Mechanical Draft—"An application of fans for securing the highest efficiency of fuel and the greatest steaming capacity of boilers."—*Fiske.*

THE VILLAGE BLACKSMITH

"From the manufacture of his modest equipment mightier things have grown."

ILLUSTRATED CATALOGUE OF

BUFFALO MECHANICAL DRAFT APPARATUS

Induced and Forced Applications of

Mechanical Draft to Central Power Stations in Street Railway,

Electric Light, Steamship Plants and Industrial Works,

With Illustrations of Suitable Fan Types

Buffalo Forge Company, Buffalo, New York, U. S. A.

OFFICES IN PRINCIPAL AMERICAN AND EUROPEAN CITIES

Registered Cable Address, "FORGE"

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Preface.

THE NINETEENTH CENTURY has been pre-eminently the era of economy in production. Increasing competition in all branches of the arts and sciences has inevitably resulted in cheapening the cost of manufacture, and there is hardly an industry that has not seen the invention of some automatic or semi-automatic labor-saving device by which the work of men's hands has been brought to a minimum.

These devices have almost universally taken the form of machines, and the power for running these has necessarily become a most important factor in determining the cost of production. With the growth of manufacturing centers, water power has become inadequate or not sufficient to be depended upon, and the rise in value of real estate has necessitated the utilization of every available foot of floor space.

Any system of figuring costs brings the owner's close attention to the coal pile, and the increasing smoke nuisance has likewise engaged the eye of the public, resulting in the enforcement of smoke ordinances.

From all these causes, it is natural that men should look for some improvement in the method of production as well as utilization of power. The tubular boiler has superseded the original plain tank of boiling water, and the water-tube boiler is a later addition, the object being the more rapid production of steam, and to secure the maximum heating effect from the coal consumed. To this end, various draft-improving and regulating devices have also been put on the market, first as supplementary to, and later as improved substitutes for, the chimney. One of the first of these, and the one which best satisfied all requirements, was the fan.

Stating briefly the considerations which have led to the use of the fan for mechanical draft, they are: first cost; economy in operation under any load, light or heavy, within the capacity of the boiler; increased efficiency in steam generated per pound of fuel; close automatic regulation of steam pressure carried on the boiler; and adaptability in form and proportions to use any available space. These desirable points, with additional features, will be considered more in detail in the following pages.

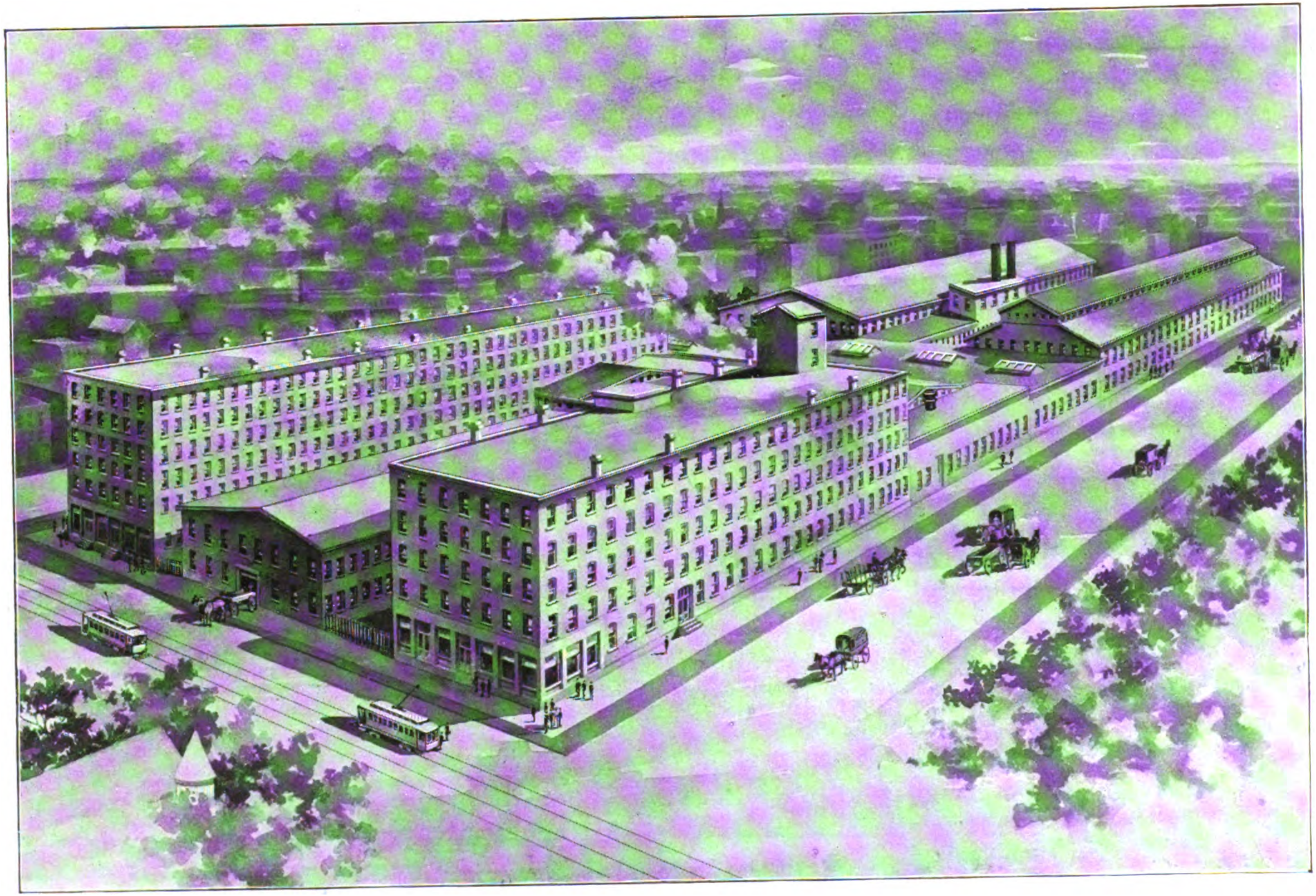
This catalogue also contains cuts showing various types of Buffalo Mechanical Draft Fans, and engines for driving them, with illustrations from photographs of installations in operation. The tabulated data also given will be found of service in obtaining general information on the various points of application. The services of our engineering department are at all times at the command of prospective customers, who will thus receive the benefit of our experience dating back to the first use of mechanical draft, and the special apparatus which is often required for the economic use of the cheapest fuel in that locality.

BUFFALO FORGE COMPANY,

BUFFALO, N. Y., U. S. A.

Buffalo Mechanical Draft Apparatus

View of the Manufacturing Plant



WORKS OF THE BUFFALO FORGE COMPANY, BUFFALO, N. Y., U. S. A.

Buffalo Mechanical Draft Apparatus

Description of the Manufacturing Plant

BUFFALO.—With regard to those advantages of location which largely determine the relative commercial and industrial standing of a city, Buffalo is especially favored. Within easy reach of New York and Philadelphia on the east for foreign shipping, and in close connection on the west with the great consuming centers of this country, its commercial facilities are superb. Twenty-eight railroads, the Erie Canal and the great lake boat lines give Buffalo unsurpassed transportation advantages. Again, the city enjoys a bounteous power supply, for Buffalo is a great distributing center of coal, while the Falls of the Niagara, twenty miles distant, stand perpetually alone in the world for vastness of water power. Falls power, extensively used in Buffalo, is connected with the shops of this company for use as desired.

LOCATION OF PLANT.—The works of the Buffalo Forge Company are situated less than a mile from the center of the city and occupy the entire block bounded by Broadway, Mortimer, Tousey and Champlain Streets. The Broadway and the Sycamore electric railway lines, of which the former is the more direct, afford ready access to the works from depots and hotels.

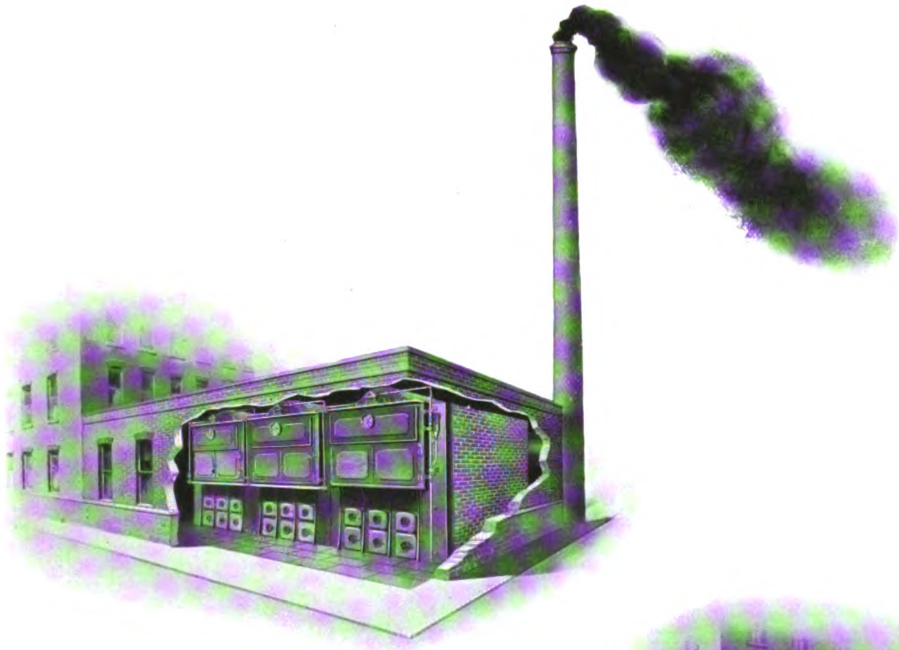
THE BUILDINGS.—The first floor of the five-story southeast building is occupied by the offices of the company; on the second are the draughting rooms and pattern shop, while the three upper floors are devoted to the construction of Buffalo Disc Wheels, "B" Volume Blowers and Exhausters. Adjacent to this building is located the new power house. The Buffalo Mechanical Induced Draft System is arranged in conjunction with the boiler plant to supply the requisite draft, which is automatically regulated for a constant steam pressure sufficiently high for the most rigid tests. Buffalo Direct-connected Tandem Compound Engines furnish current for the shop motors. The center front building is the sheet iron department. In the northeast building is the fan system heater department, where immense quantities of pipe are used annually. Here also is situated the forge shop, equipped with the Buffalo Down-draft Forge System, hence smoke does not pervade the shops.

On the top floor of the new six-story building, Buffalo Portable Forges, Hand Blowers and other blacksmith tools are built, and on the fifth floor Buffalo Down-draft and Heating Forges. The fourth floor is devoted to the construction of Buffalo Steel Pressure Blowers. The painting, crating and temporary storage of light machines is done on the third floor, where also are located certain shop offices. The second floor provides space for the tool room and finishing of engine parts. On the first floor, and extending into the adjacent central building, are the engine machine shops, furnished with special tools, and thoroughly equipped for engine building.

In the adjacent central building is located a thoroughly equipped engine-testing room. In this building, also, the large steel plate heating and ventilating fans are constructed, with facilities for thorough testing. A modern foundry occupies the northwest building, and adjacent thereto are the pattern vaults. A one and a half story gallery type building on an adjacent street, and not shown in the cut, furnishes a warehouse for storage purposes.

Buffalo Mechanical Draft Apparatus

Mechanical Draft vs. Natural Draft



View of boiler plant equipped with natural draft, showing the chimney required

View of boiler plant equipped with forced draft, showing the fan and stack required

Buffalo Mechanical Draft Apparatus

Mechanical Draft vs. Natural Draft

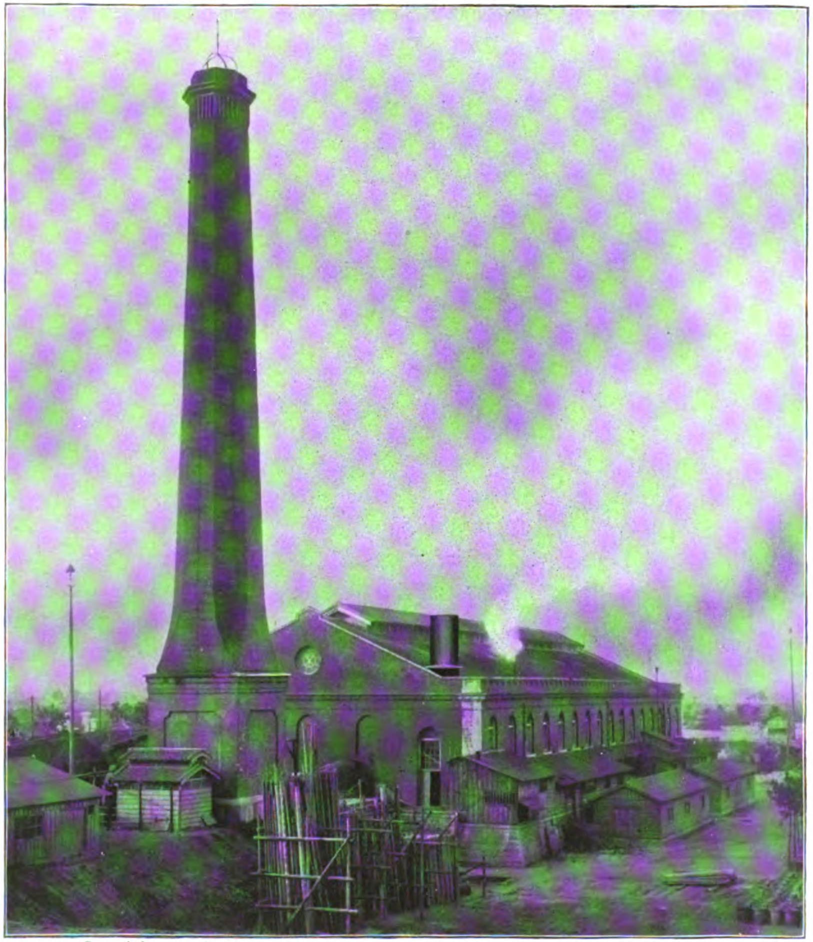
The initial cost of mechanical draft apparatus, breeching, fan, engine and stack, is far less than the first cost of a chimney. The expense of operating a mechanical draft plant is below the interest on a smoke stack outlay. With natural draft, over one-fourth the total calorific power of fuel is wasted in forming a draft while the steam used to produce draft by mechanical means never exceeds two per cent. of the steaming capacity and is often as low as one-half of one per cent. With natural draft the temperature of the flue gases should not be reduced below six hundred degrees; and it must be remembered that although the draft intensity and volume of air moved increases with the temperature of the gases, the density decreases at the same time, so that between 600° and 700° F. a temperature is reached at which the weight of air handled is a maximum. Hence, a chimney fixes once for all the maximum power of the boiler plant.

With mechanical draft the temperature of the flue gases need not be above the temperature of the outside air, so far as the intensity of draft is concerned. This insures the maximum efficiency of fuel economizers, which utilize the waste heat of gases when installed in mechanical draft plants. The draft may be so regulated, with mechanical draft, that all the carbon of the fuel will be burnt to carbonic acid gas, giving out 14,500 units of heat for each pound of carbon burnt, but with natural draft a portion of the carbon will be burnt to carbon monoxide and only give 4,400 units of heat for each pound of carbon, or 10,100 units of heat more are given out in the mechanical draft plant. The bulk of the products of combustion is greatly reduced in volume and increased in temperature when mechanical draft is used, and therefore the boilers are more efficient than when natural draft is employed, for it is self-evident that the same area of heating surface will be more efficient in abstracting heat units from a small volume of hot gases than from a large volume of much cooler gases. The temperature of combustion in a furnace when mechanical draft is employed is about 1,000° F. above the temperature of combustion when natural draft is used. Mechanical draft insures the highest possible efficiency of combustion, the steaming capacity of boilers is increased to a maximum, and a sudden demand for steam is promptly met, but with natural draft these results cannot be obtained.

Mechanical draft is widely employed in the anthracite culm districts and is an indispensable adjunct of mechanical stokers. It is an essential for the proper combustion of sawdust, bagasse, spent tan bark and like fuels, being easily applied to old boilers at a minimum initial expense. Mechanical draft plants are easily installed, are flexible, positive and instantaneous and provide a constant boiler pressure by automatically controlling the speed of the fan. It also makes feasible a material increase of capacity without enlarging the boiler plant, burns lower grades of coal, prevents smoke and saves fuel. In a word, mechanical draft is the essential factor of advanced boiler practice.

Buffalo Mechanical Draft Apparatus

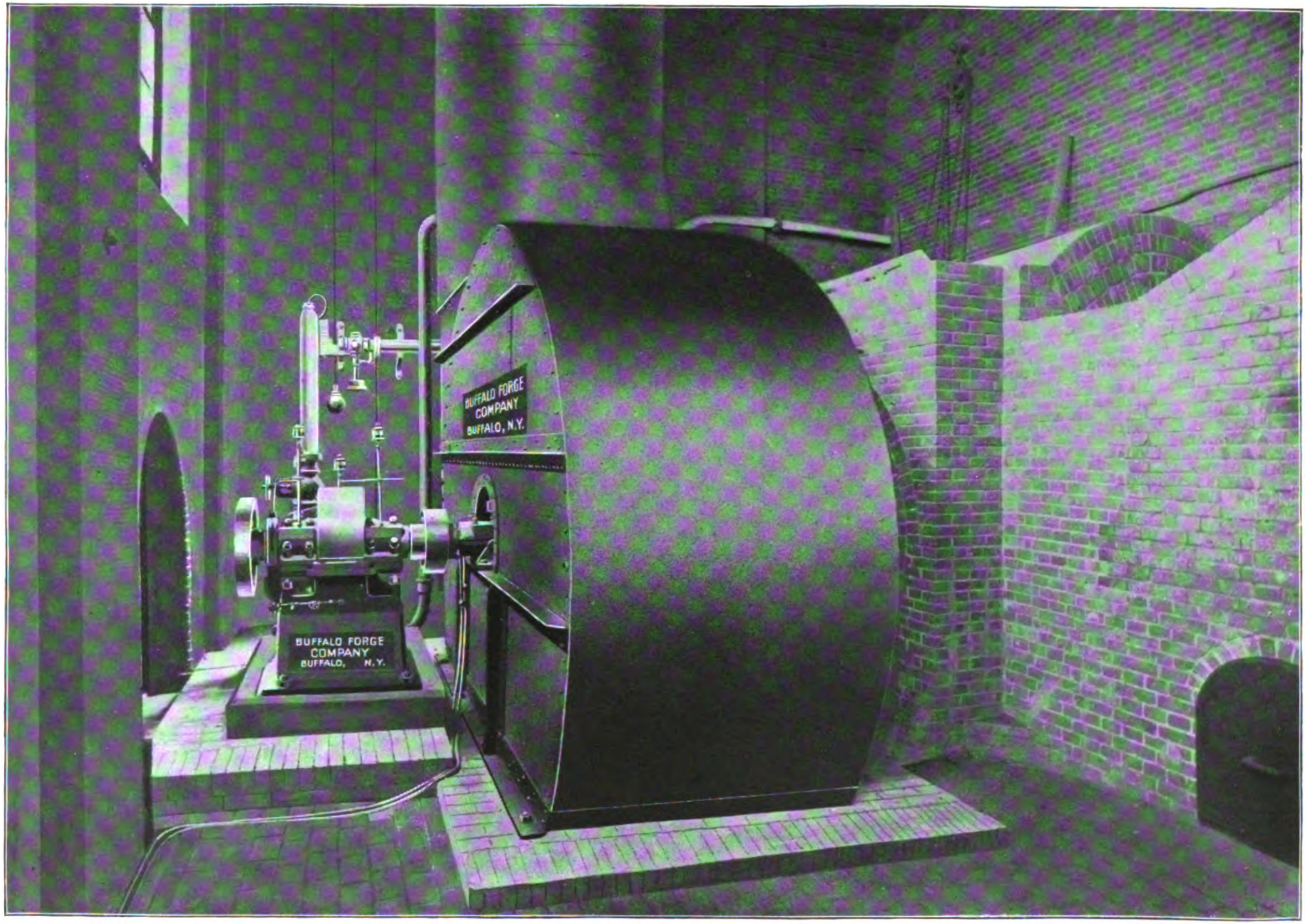
First Induced Draft Plant in Japan



Osaka Water Works, Osaka, Japan. Note size of brick stack superseded by Mechanical Draft

Buffalo Mechanical Draft Apparatus

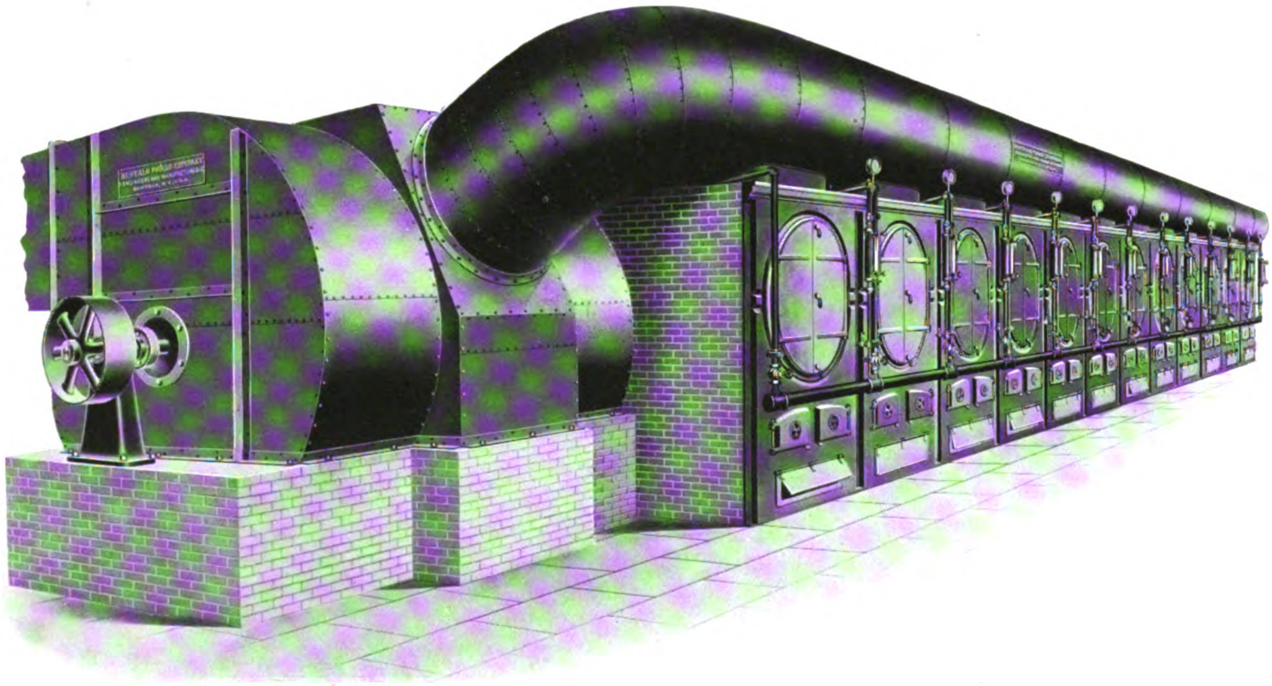
Application of Full Housing Steam Fan for Induced Draft



Induced Draft Plant at the Osaka Water Works, Osaka, Japan

Buffalo Mechanical Draft Apparatus

Boilers Equipped with Duplex Three-quarter Housing Fans



Induced Draft Plant at the Watkins Salt Company, Watkins, N. Y.

Buffalo Mechanical Draft Apparatus

Conversion of Latent Energy into Available Work

LATENT ENERGY of the coal pile is well understood by manufacturers of today and they are close observers of the process which converts this latent force into heat, or thermal energy, viz., combustion; of the apparatus by which this heat energy is transferred to water, viz., the boiler; and finally, of the mechanism where occurs the real transformation of heat into available mechanical energy or work, viz., the engine.

THE MEANS of securing the highest efficiency obtainable in this latter process is well established in theory, and expressed by the Carnot Cycle represented in the formula $\frac{T_1 - T_2}{T_1}$, meaning steam must be adiabatically expanded from maximum temperature and pressure to minimum temperature and pressure. The reasons why adiabatic expansion and also maximum and minimum of temperature and pressure are not secured are too numerous and well understood to receive cursory mention. Suffice it to say, that the efficiency of an engine, as determined by the ratio of work in foot pounds obtained from the engine to the heat expressed in foot pounds delivered to the engine, does not exceed fourteen per cent. in the best simple non-condensing engines.

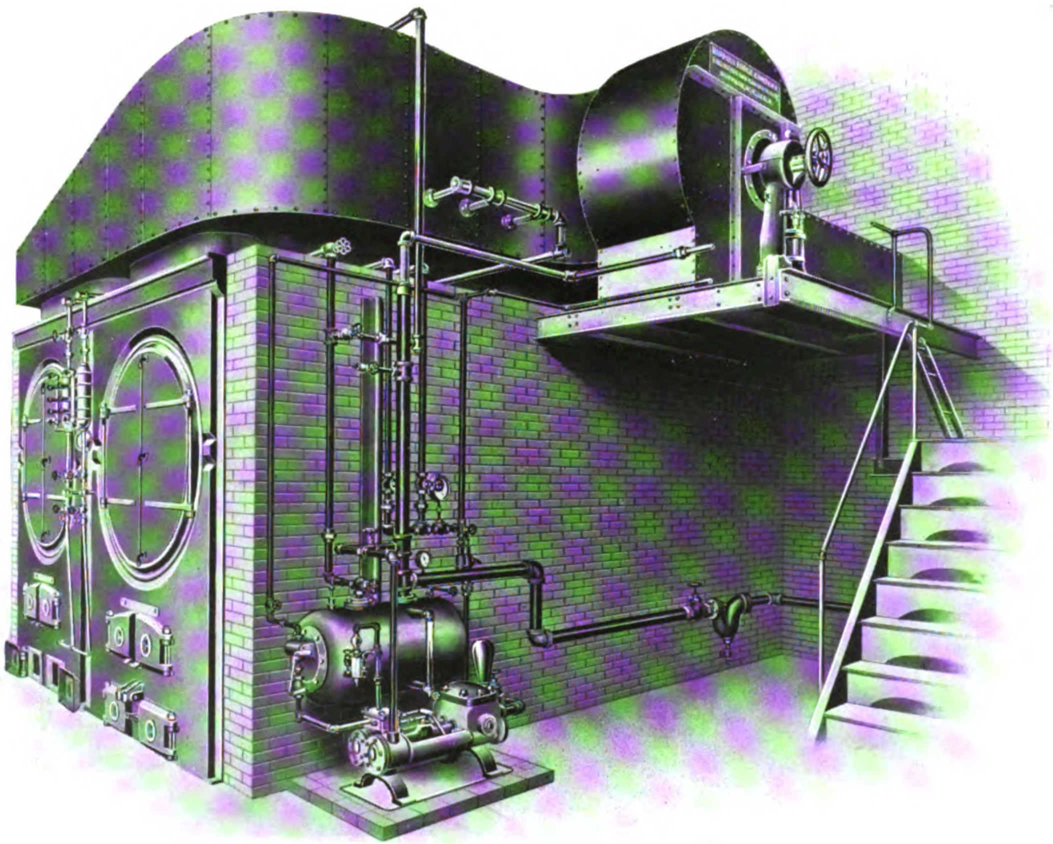
HIGHEST FURNACE EFFICIENCY would be obtained when all the heat of combustion was transferred to the water in the boiler. Manifestly, this is impossible because the diffusion of heat takes place simultaneously by three modes, viz., radiation, convection and conduction. The loss of energy occasioned by each, while they are perfectly distinct in their nature, is not easily obtained and need not here be calculated. In practice, the ratio of the heat actually expended in evaporating water to the total calorific equivalent of the fuel burnt in the grate does not in the most modern improved water-tube boilers exceed eighty per cent.

COMBUSTION, the step in the transformation that will be dwelt upon more fully, is that chemical action which rapidly unites oxygen with other elements forming various gaseous compounds. This spontaneous process sets free the energy of fuel in the form of heat and light. The combustible elements usually found in fuels are carbon, hydrogen and sulphur. Various grades of coal contain from seventy to ninety-four per cent. of carbon (C), from one to ten per cent. of hydrogen (H), from four-tenths of one per cent. to two per cent. of sulphur (S), from one to ten per cent. of water (H_2O) and from one and one-half per cent. to eighteen per cent. of ash. The heating power of fuels depends upon the proportions of the first two elements and upon the manner in which they are supplied with oxygen, as will be shown later.

HEAT PRODUCED BY COMBUSTION of any element or compound is the quantity of heat brought into existence during the complete oxidation or burning of the element or compound to form the masses of the products of oxidation which are represented by their formulæ. The heat of formation of a compound, that is, the product of combustion of an elementary substance, may be obtained by burning a known quantity of the element in a water or other suitable calorimeter and calculating the heat developed.

Buffalo Mechanical Draft Apparatus

Application of Three-quarter Housing Steam Fan for Induced Draft



Induced Draft Plant at the Works of the Buffalo Forge Company, Buffalo, N. Y.

Buffalo Mechanical Draft Apparatus

Conversion of Latent Energy Into Available Work—Continued

When the elements composing the compound do not unite directly, the heat of formation may be found by obtaining the heat of combustion of each of the elements, for the products of combustion will be the same as those of its constituent elements or of the compounds. The heat may be less after the combination of the elements than before, in which case, it would be evident that heat is absorbed in forming the compound, and must be considered as negative heat, and be taken from the total heat of formation.

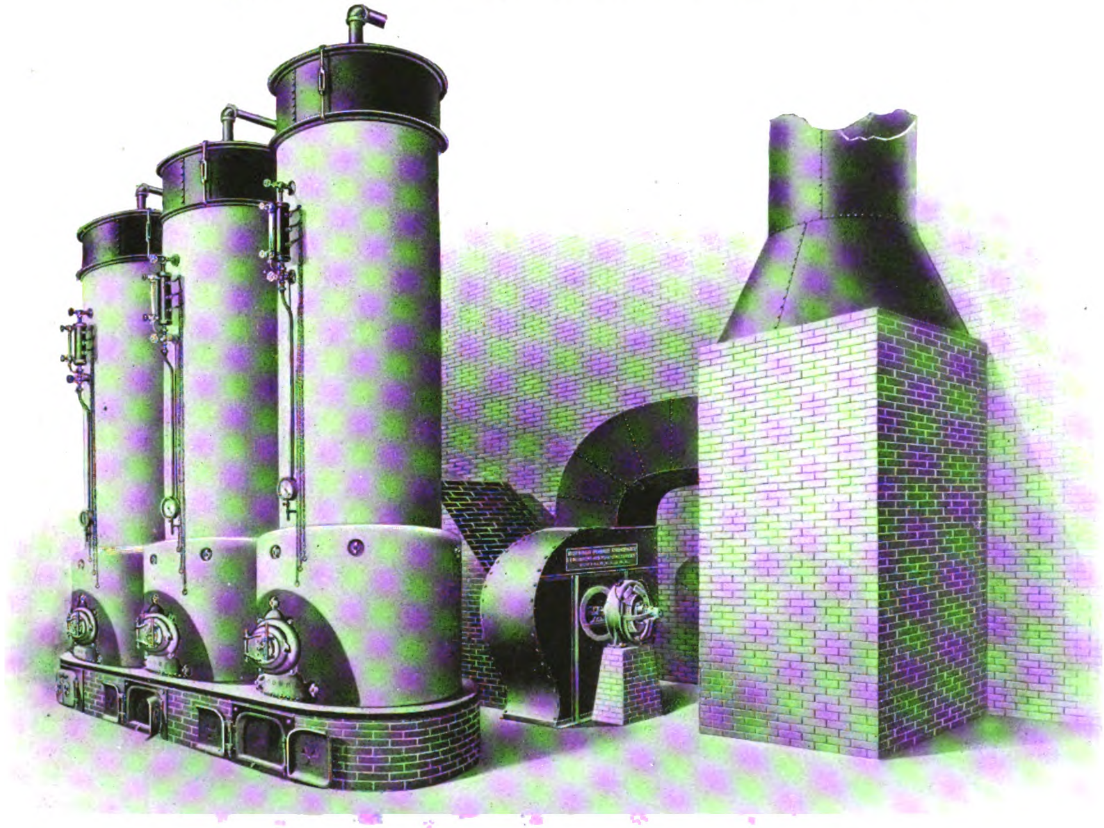
Methane (CH_4), a compound of carbon and hydrogen, gives a fair example of the foregoing principle, which remains the same in more complex cases. The heat of perfect combustion of carbon (C) to CO_2 equals 96,960 British thermal units, the heat of combustion of hydrogen (H) to 2 (H_2O) equals 136,720 units, and the heat of combustion of methane (CH_4) to CH_4O_4 equals 211,930 units. Therefore, the heat of formation of methane (CH_4) = CO_2 + 2 (H_2O)—(CH_4 O_4) = 96,960 + 136,720—211,930 = 21,750.

Regarding the combustion of a pound of fuel as that of a known weight of carbon and hydrogen, the amount of heat evolved during combustion may be determined from the heats of formation. Carbonic acid (CO_2) contains twelve parts by weight of carbon to one of oxygen, and the combustion of one pound of carbon gives 14,500 B. T. U. Water (H_2O) contains two parts by weight of hydrogen to one of oxygen, and the combustion of one pound of hydrogen gives 62,100 heat units. The heats of formation of these chemical compounds, which are already formed must be taken from the total heat of combustion of the elements. In practice, water is the only such compound taken into consideration. All oxygen given by analysis it is assumed was in the fuel, in combination with hydrogen as water, known as "water of formation", because it is not driven off when the fuel is raised to the boiling point of water. Therefore, to determine what is called the calorific power of fuel, first subtract one-eighth part by weight of all the oxygen from the hydrogen, and then calculate from the given heats of combustion those of the carbon and remaining hydrogen, and finally subtract the amount of heat required to raise to the state of steam the whole of the water of formation and other water that may be present.

Taking the average composition of five samples of coal, as determined by analysis, to be carbon 80.07, hydrogen 5.33, oxygen 8.08, nitrogen 2.12, sulphur .5, and ash 3.7 per cent. by weight and remembering that it requires 1.01 of hydrogen to satisfy the 8.08 of oxygen to form 9.09 of water, we have C = 80.07, H = 4.32 and H_2O = 9.09. The calorific power of one pound of this coal = $0.8 \times 14{,}500 + 0.043 \times 62{,}100 - 0.09 \times 1{,}118. = 14{,}170$ B. T. U. The heat required to raise one pound of water from 60° and evaporate it at atmospheric pressure equals 1,118. B. T. U. Therefore, this coal has a calorific power sufficient to raise $14{,}170 \div 1{,}118 = 12.67$ pounds of water from 60° F. and evaporate same at atmospheric pressure. The amount of heat obtained and water actually evaporated will be much less than the above theoretical amount because of heavy losses which cannot be avoided but are decreased by employing artificial draft. These losses will be enumerated.

Buffalo Mechanical Draft Apparatus

Application of a Single Electric Fan with Economizer



Induced Draft Plant of the United Traction Company, Albany, N. Y.

Conversion of Latent Energy into Available Work—Continued

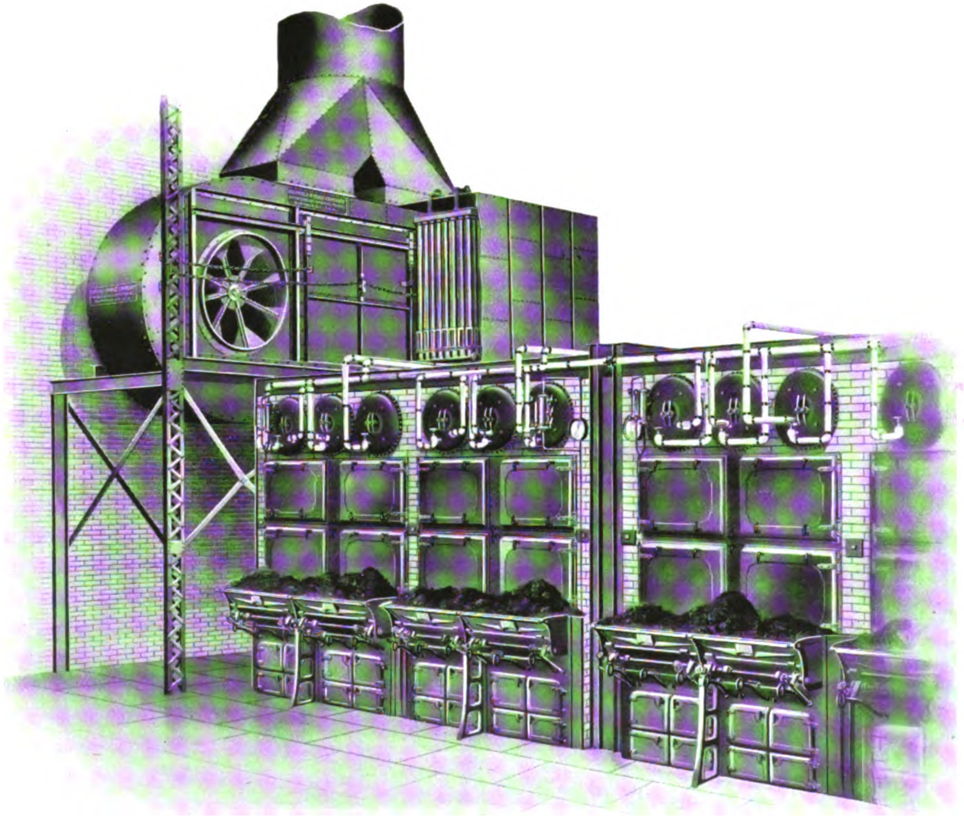
TEMPERATURE OF THE PRODUCTS OF COMBUSTION depends upon their weights and specific heat. The quantity of air supplied to the fuel largely determines the weight of the products of combustion. When one pound of carbon burns to carbonic acid gas, it requires two and two-thirds pounds of oxygen or twelve pounds of ordinary air. One pound of hydrogen gas requires eight of oxygen or thirty-six pounds of ordinary air.

In practice, more than the theoretical amount of air is required to effect a total combustion of the fuel. The nature of the draft determines the amount of extra air required. More than twice the theoretic amount is required when the draft is produced by a chimney, viz., twenty-four to thirty-six pounds of air per pound of carbon. This excess of air is required because a chimney does not produce a draft of sufficient intensity to penetrate a heavy bed of coal. The bed of coals must be thin and the larger portion of the air does not aid combustion but mingles with the products of combustion, reducing their temperature. With artificial draft, the amount of air required for perfect combustion is one and one-fourth to one and one-half times the amount required in theory. This decrease in the amount of air required is made possible with the artificial draft because of the heavier bed of fire that it is practicable to use and the closer contact between the air and fuel. Although common coal is a complicated mixture of carbon, hydrogen and oxygen, no serious error will be committed by estimating the quantity of air required for its combustion on the supposition that it is pure carbon, as this is done only with the view of showing how the temperature of the products of combustion vary according to the nature of the draft. With artificial draft, one pound of carbon requires 17 pounds of air, and the total weight of the products of combustion will be $17 + 1 = 18$ pounds. With chimney draft, a good average of the air required for the combustion of one pound of carbon would be 29 pounds. Then the products of combustion with natural draft is $29 + 1 = 30$ pounds. In each case the total heat of combustion will be 14,500 units. The specific heat of air at constant pressure is 0.237. In the case of natural draft, the products of combustion would have a temperature equal to $\frac{14{,}500}{30 \times .237} = 2{,}039$ degrees. On the other hand, with artificial draft we would have a temperature equal to $\frac{14{,}500}{18 \times .237} = 3{,}636$ degrees, or very nearly 1,600 degrees higher temperature than the chimney draft gave with the same rate of combustion. That this question of initial temperature and weight of the products of combustion assumes an important aspect in the economy of the boiler and furnace will be shown.

HIGH RATES OF COMBUSTION, accomplished by increased coal consumption, are not necessarily helpful to best economy. However, a higher efficiency must result when the amount and quality of coal remains the same, and the higher rate of combustion is accomplished by a decrease in the grate surface and a corresponding increase of surface ratio. Attention is here called to curves on page 44.

Buffalo Mechanical Draft Apparatus

Horizontal Tandem Fans – Casing and Economizer Partly Removed to Show Damper



Induced Draft Plant of the United Electric Company of New Jersey, Hoboken, N. J.

Buffalo Mechanical Draft Apparatus

Conversion of Latent Energy into Available Work—Continued

Radiation and Conduction are often causes of heavy heat losses in boiler plants. However, when the boiler is properly surrounded by non-conducting material, such as good brick side walls with four-inch air spaces inclosed and a layer of brick or an asbestos covering over the top of the boilers, it is about 10 per cent. and does not vary enough to claim consideration here.

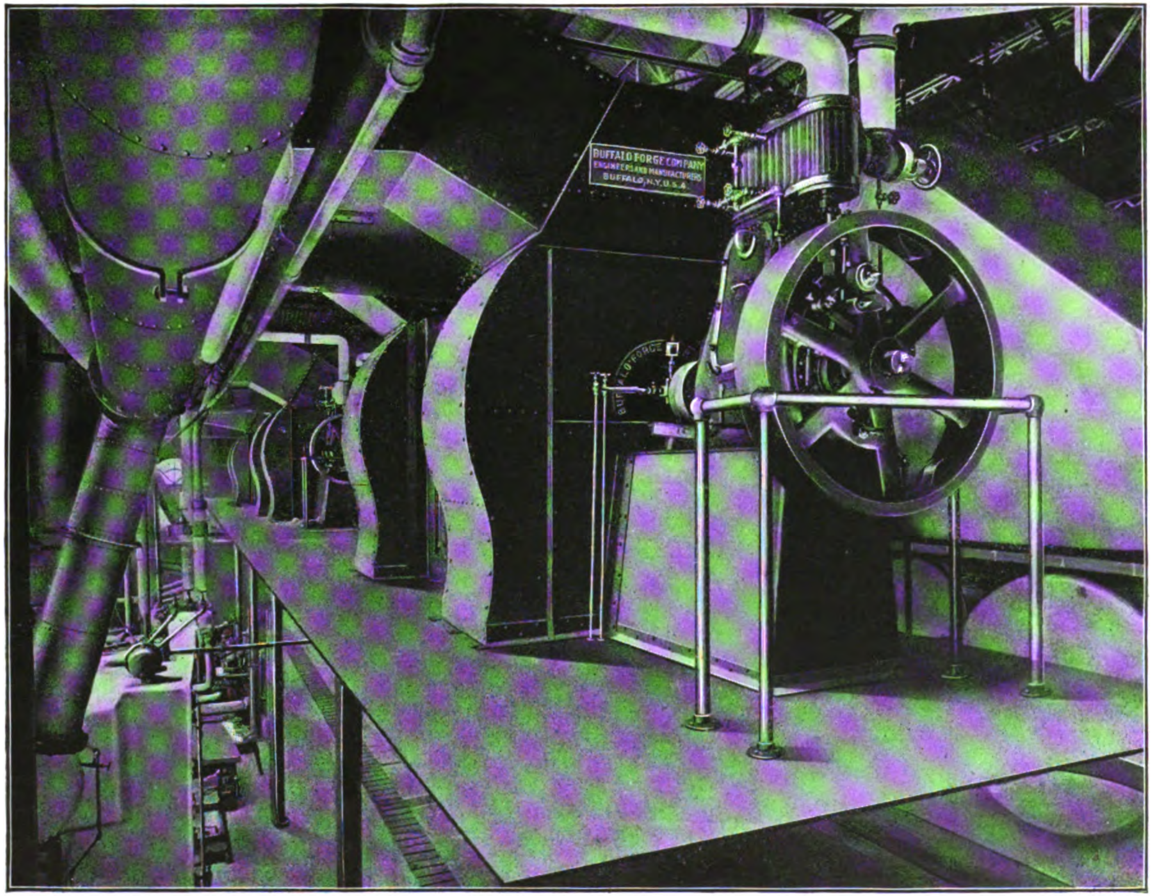
Evaporative Power of Coal, in practice, falls far short of its theoretic value. The ways in which the calorific power of fuel is wasted are various. Anthracite and a very dry coal are extremely brittle when suddenly exposed to high temperatures, and when the bed of fuel is thin the small splinters break off and fall through between the bars of the grate. Again, if the draft be poor and a sudden demand for steam be made upon the boiler plant, it becomes necessary to do considerable stoking, an operation always attended by loss from partially consumed fuel falling through the grate and cooling of the heating surface caused by opening the furnace door and knocking of holes in the thin fire. The greatest waste of fuel, however, usually takes place in the gaseous state. The upper layer of fuel is heated through, in the ordinary coal fire, long before these upper layers become incandescent. During this time the coal is partially distilled, and much of its most valuable constituents are driven off in the gaseous state and escape up the chimney unburnt. When special provision is made to allow warm air to mingle with these gases above the grate, they may be burnt above the bed of the fuel. With artificial draft this is unnecessary, as the temperature of combustion and surplus air, after passing through the heavy bed of fuel, is sufficient to insure combustion of these gases.

Very great loss is often caused by an insufficient supply of air to the fuel, for if only enough oxygen be present to burn the carbon into carbonic oxide, the units of heat generated will be 4,400 per pound of carbon instead of 14,500 units of heat generated when carbon is burnt to carbonic acid. A very large quantity of carbonic oxide may easily escape detection, as it is a perfectly colorless gas. If this gas be mingled with a sufficient amount of air and again ignited it will burn to carbonic acid, and give out the missing 10,100 units of heat.

Formation of Smoke, which is pure unburnt carbon, is a fruitful source of waste, and is also a very common one. The large black volumes of smoke seen issuing from stacks is made up of unburnt carbon mingling with the products of combustion which are colorless. The most fruitful smoke-producers are fuels which contain large quantities of hydrocarbons. At a high temperature, these hydrocarbons are driven off in large quantities which are mixed with the products of combustion above the fuel. These fine particles become cooled when they come in contact with the air, and show themselves in the form of smoke. The higher temperature produced in the furnace by artificial draft insures the complete combustion of these hydrocarbon gases when they come in contact with that portion of the air, which has been raised to a high temperature by being drawn through the heavy bed of fuel, and therefore prevents the smoke nuisance.

Buffalo Mechanical Draft Apparatus

Angular Discharge Fans with Double Vertical Enclosed Engine



Induced Draft Plant of the W. J. Lemp Brewing Company, St. Louis, Mo.

Buffalo Mechanical Draft Apparatus

Conversion of Latent Energy into Available Work—Continued

Draft to Feed the Furnace with air often produces the largest waste of fuel. This draft may be produced either by means of a chimney or by artificial means. It is found that a temperature of 600 degrees F. is best for the ascending gases in the case of the chimney. The temperature of the furnace is only about 2,300 degrees above that of the outside air, therefore about one-fourth the total energy of the fuel is wasted in producing draft with the chimney. This shows how wasteful of energy the chimney is, for in order to produce the necessary draft, twice the allowance of air must be had and these larger volumes of gases are carried off at a very high temperature. With the artificial draft it becomes unnecessary, so far as draft is concerned, that the stack gases have a higher temperature than that of the outside air, insuring highest efficiency of fuel economizers, while the necessary air supply is less by one-half than when a chimney is used.

Boilers Cannot Absorb all Heat of the products of combustion because of the nature of the conduction of heat through the boiler plate, which separates the fire and gas from the water. The rate of conduction depends upon three conditions: first, upon the difference in temperature between the sides of the plate, the rate of conduction being more rapid as the differences in the temperatures of the two sides increases; second, upon the thickness of the plate; and third, upon the conductivity of the metal which forms the plate.

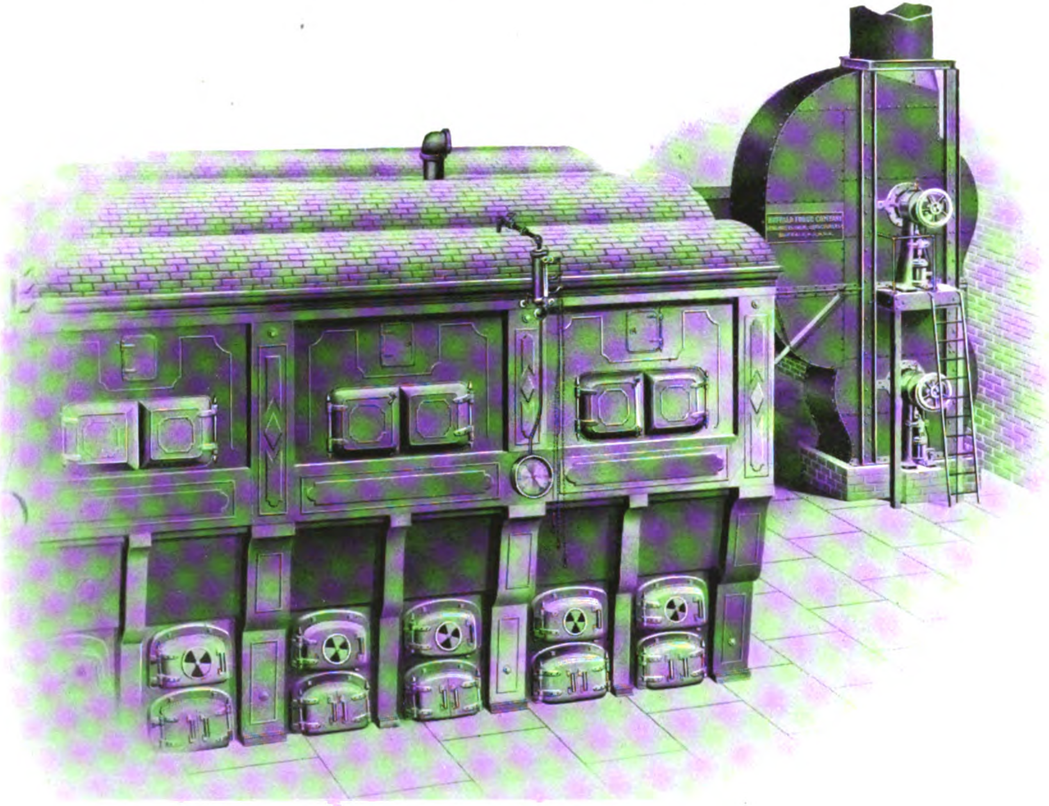
It is evident that when there is no difference in temperature between the sides of the plate, there can be no transfer of heat through the plate. Thus, the water in a boiler has a temperature of 337.5 degrees when the gauge pressure is 100 pounds; therefore the hot gases coming from the fire can only be reduced to that temperature by the boiler, and must escape to the stack at said temperature. However, it is impossible to retain these gases long enough in contact with the boiler to allow their temperature to become the same as that of the water in the boiler, and for this reason more heat is wasted than has been stated above. To a limited extent, this heat may be saved by the introduction of feed-water heaters at that point of the boiler where the gases are coldest. This arrangement is always employed in modern manufacturing and power plants and often reduces the fuel bill 15 per cent.

From the Foregoing, it is clear how important it is to reduce the air supply to the fuel to the minimum amount consistent with perfect combustion of the fuel. An excess of air reduces the temperature of combustion within the furnace, thus diminishing the rate of conduction through the boiler plates and it also increases the bulk of the gases of combustion, making it more difficult for the heating surface to reduce their temperature to that of the water within the boiler, for it is evident that a given area of heating surface is more efficient in separating the heat from a small volume of hot gases than from a large volume of cool gases.

It is Undeniable that artificial draft is far less wasteful of heat units than natural draft. The accepted way of producing this artificial draft is by means of the fan, and therefore known as Mechanical Draft.

Buffalo Mechanical Draft Apparatus

Vertical Tandem Fans with Cylinder Below Shaft Engines



Induced Draft at the Plainfield Gas and Electric Company Plant at Plainfield, N. J.

Buffalo Mechanical Draft Apparatus

Buffalo Fans Applied for Mechanical Draft

Application of Mechanical Draft assumes three general forms: First, Induced draft by the installation of fans to serve as a chimney. Second, Forced draft by applying fans to force air beneath boiler grates. Third, The combination of induced and forced draft, obtained by fans applied to serve both purposes or by separate fans for each. Many large plants are now installed where this combination is employed, the combined forced and induced draft system being brought about on account of equipping the boilers with any make of stokers, outside of the chain type or those having the open ash pit. Air, under a pressure of one and one-fourth to two ounces, is delivered to the stokers by a forced draft fan, the separate induced draft fan or fans being connected, in the ordinary manner, with the boiler breeching, with or without economizer in connection, and discharge the gases through a steel stack into the atmosphere. Under this class may also be included the method of burning powdered fuel in suspension. The practicability of the system has been thoroughly demonstrated by tests extending over a number of months, but, while the system has shown a marked degree of efficiency, it has seldom been made use of in practice. The selection of the proper type to render the highest economy, primarily depends upon the fuel to be consumed, and the various conditions of the steam plant to be outfitted. It is readily seen, that no single one of these three applications of mechanical draft will give the best results in all cases, but that every boiler plant must be carefully treated individually.

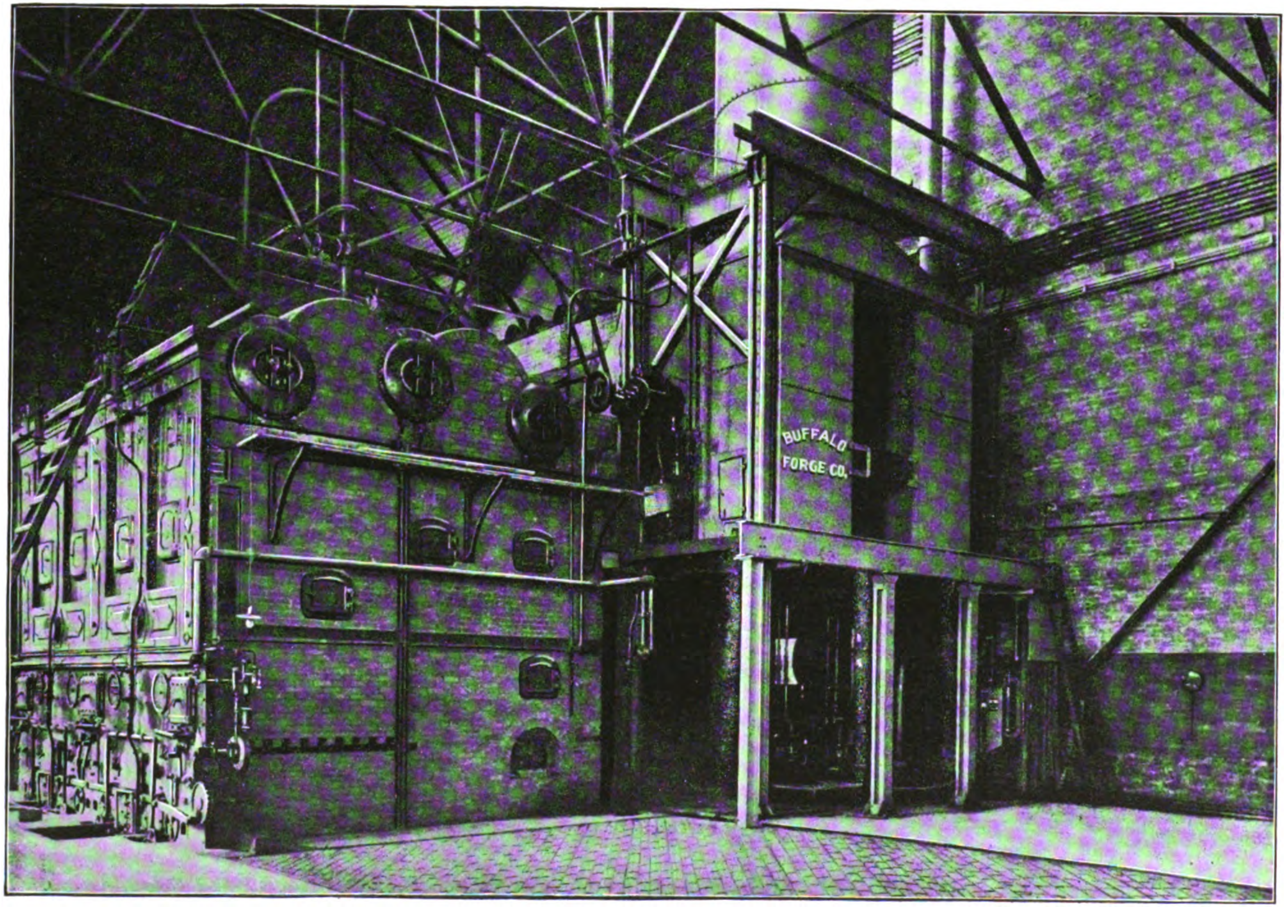
Culm Banks.—Officials in control of those in Pennsylvania and other anthracite coal sections are directing attention to the utilization of this accumulation of years. Early use of the primitive steam jet for culm fires soon showed the necessity of a fan to secure unvarying high efficiency. Culm is no exception to better grades of coal, and demands sufficient air for maximum efficiency of combustion. Pioneer mechanical draft plants for burning culm were installed by this house, and after long continued use are, today, forcible examples of the feasibility of deriving from this waste a surprisingly great efficiency compared with higher grades of coal. Complete test records of steam plants, including not only those replete with all accessories to a modern outfit, but a variety of those more limited in equipment, will be cheerfully supplied to intending purchasers.

Induced Draft has become the most common form of mechanical draft in power plants, and is ordinarily used in conjunction with fuel economizers. The following is an extract from a paper read by Mr. Wm. R. Roney, at the Montreal meeting of the American Society of Mechanical Engineers:

"Importance of Good Draft, natural or artificial, for supplying sufficient oxygen for the economical combustion of fuel has long been recognized by intelligent engineers. The gain, both in efficiency and capacity, obtained by the rapid and energetic combustion of fuel, and the resulting high furnace temperatures is well established. Its importance has been generally conceded only within a few years. To obtain this high furnace temperature requires draft sufficiently strong to deliver an abundant supply of oxygen to the furnace.

Buffalo Mechanical Draft Apparatus

Full-Housing Duplex Fans with Economizer



Mechanical Induced Draft at Columbus Street Railway, Columbus, Ohio

Buffalo Mechanical Draft Apparatus

Buffalo Fans Applied for Mechanical Draft—Continued

"Mechanical Induced Draft is by no means a new idea, yet it is only within a few years that the same draft has been much used or installed on a large scale. Previously it had been used, with a few exceptions, for the purpose of improving poor draft by helping out an insufficient or an overloaded chimney. The largest and most successful applications of mechanically induced draft have been made in connection with feed-water heaters designed to utilize the waste heat of the flue gases, and known as fuel economizers. This form of feed-water heaters has been manufactured in England for over fifty years. They have, however, been imported for many years, as their value as a fuel-saving device is well established. Their successful operation is so dependent upon good draft that no well-informed engineer would think of installing an economizer without making provision for much better draft than the boilers would require without it. On account of the reducing effect on the draft, caused by lowering the temperature of the gases and retarding their flow by the mechanical interference of the pipes, it cannot be considered good engineering to attach an economizer to a chimney less than 200 feet in height. The best working economizers in connection with chimneys are those where the chimney is considerably over 200 feet high.

"Objections urged against tall chimneys, as compared with mechanical draft, when used with economizers, are: First; Excessive cost, both on account of the height required and on account of foundations, which must of necessity be very substantial, and which may involve expensive piling and filling. Second; The space required for foundations, which may be very valuable, especially in large cities, or may be required for other purposes, and which can with difficulty be spared. A chimney 250 feet high will require foundations not less than 30 feet square, and in some cases much more. Third; A certain minimum temperature of flue gases is required to produce an effective draft and to operate the boilers economically, and this fact limits the amount of economizer heating surface which can be used, and consequently, the fuel saving obtained by use of the economizer. The same fact operates unfavorably at small capacities, which are often unavoidable, when the chimney must be built large enough for future increase of the boiler plant. Fourth; A chimney once built limits the maximum capacity of the boiler plant, and also is liable to be affected by atmospheric changes which may seriously impair its efficiency.

"These objections to tall chimneys, which are so essential to the use of economizers, do not hold with mechanical draft. The first cost of a properly designed mechanical draft plant is very much less than that of a suitable chimney of equal capacity, usually averaging 50 to 60 per cent. less, according to the size of chimney and character of foundations required. The fans and short stack require very little foundations, even less than that of an ordinary boiler setting. The space usually required for extensive chimney foundations can be utilized for economizers, and, by elevating the economizers and fans upon beams and columns, the space underneath them can be used for pumps, condensers, etc. (see page 26). The space thus saved is often of great value.

Buffalo Mechanical Draft Apparatus

Duplex Type of Fans Placed Above Boiler Setting

Induced Draft Plant of the Miner-Hillard Milling Company, Miners Mills, Pa.

Buffalo Mechanical Draft Apparatus

Buffalo Fans Applied for Mechanical Draft—Continued

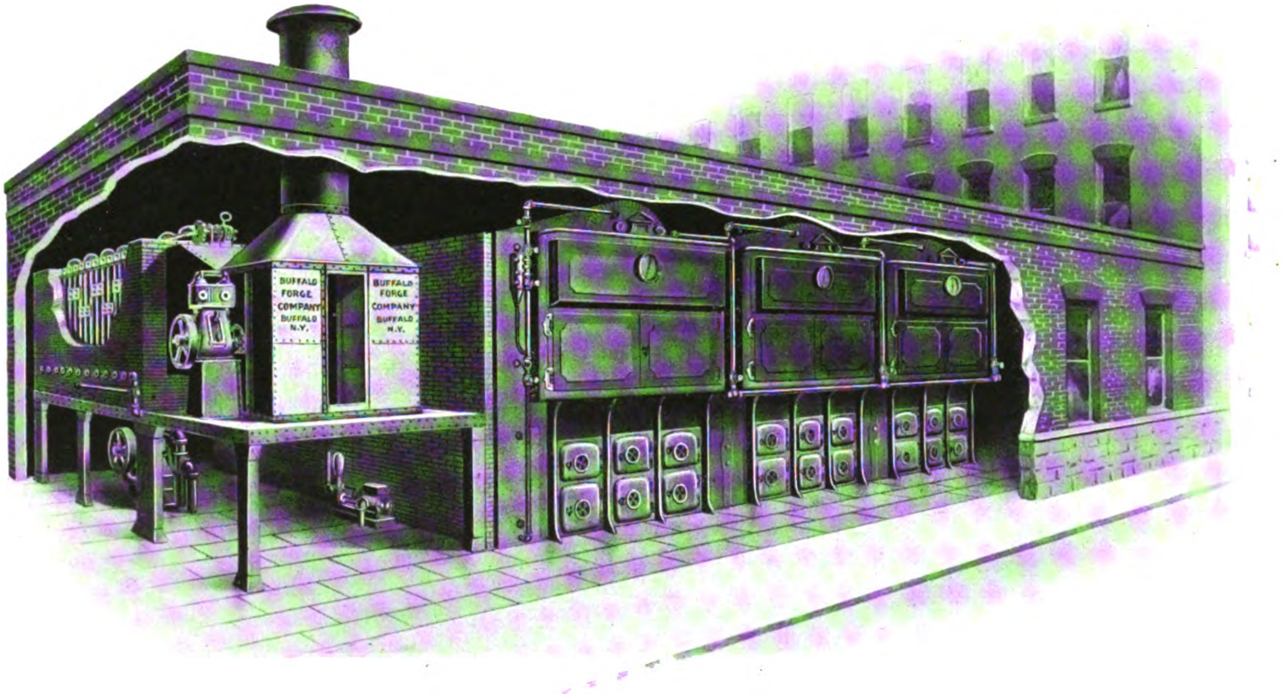
"NATURAL DRAFT REQUIRES that the gases in the chimney be above a certain minimum temperature in order to secure a proper supply of oxygen in the furnace and good combustion of the fuel, whereas with mechanical induced draft, the amount of draft obtainable is entirely independent of the temperature of the flue gases, and when used in combination with a properly proportioned economizer, it is possible to lower their temperature to a point where the draft of even a very tall chimney would be practically destroyed. Mechanical draft possesses great advantages over natural draft in its flexibility and adaptability to both large and small capacities, and in its ability to meet sudden and excessive demands for steam, either by an extra turn of the throttle valve, or by an automatic regulator controlling the steam supply to the fan engine according to the boiler pressure. It is unaffected by atmospheric changes, furnishing the desired amount of draft irrespective of conditions of wind or weather. Operating independently of the amount of heat in the stack, it is possible to obtain a higher temperature of feed water in the economizer, and a lower temperature of escaping gases than could possibly be obtained with a chimney, and, at the same time, provide sufficient draft to maintain rapid and economical combustion of the fuel. A mechanical draft plant properly designed, with duplicate fans and engines of suitable construction, so arranged that one is always in relay, can be made so reliable that the boilers cannot be shut down by an ordinary accident. With the fans properly designed and proportioned to the work, the power required to operate them is so small as to practically have no effect on the economy obtained.

"A COMPLETE BOILER HOUSE (illustrated on page 30), showing boilers, stokers, circulating economizer, mechanical draft, feed pumps, and condenser, will be of interest. In this illustration, the economizer is elevated upon columns and beams to provide for utilizing the space under the economizer for feed pumps, condenser, etc. The exhaust fans, of which there are two placed side by side, are equipped with double direct-connected engines, only one engine showing in the illustration, the other being on the farther side. These fans and engines are of special design, with protected bearings, self-oiling and water-jacketed, to withstand the heat when the economizer is cut for cleaning, and the hot gases pass directly to the fans. They are so proportioned to their work as to handle a maximum amount of gases with a minimum expenditure of power. The arrangement of the economizer pipes and blow-off connections is worth noticing, in that it provides a means of blowing out the sediment which may accumulate in the pipes, and at the same time a complete circulation is maintained in the economizer.

"THE FOLLOWING DATA will be of considerable interest, as showing in tabulated form the results obtained by economizers and mechanical draft in a number of plants in regular service. In each case the feed-water was partially heated by exhaust steam heaters, or in hot wells by condensed steam from various sources."

Buffalo Mechanical Draft Apparatus

Duplex Type of Fans with Cross Compound Engines



Modern Boiler House with Induced Draft and Economizer

Buffalo Fans Applied for Mechanical Draft—Continued

TESTS OF ECONOMIZER AND MECHANICAL DRAFT PLANTS, SHOWING INITIAL AND FINAL TEMPERATURES OF FLUE GASES AND FEED WATER IN DEGREES FAHRENHEIT.

Tests.	Gases Entering Economizer.	Gases Leaving Economizer.	Water Entering Economizer.	Water Leaving Economizer.	Gain in Temperature of Water.	Fuel Saving, Per Cent.
1	610	340	110	287	167	16.7
2	505	212	84	276	192	19.2
3	550	205	185	305	120	12.0
4	522	320	155	300	145	14.5
5	505	320	190	300	110	11.0
6	465	250	180	295	115	11.5
7	490	290	175	280	105	10.5
8	495	190	155	320	165	16.5
9	541	255	130	311	181	18.1

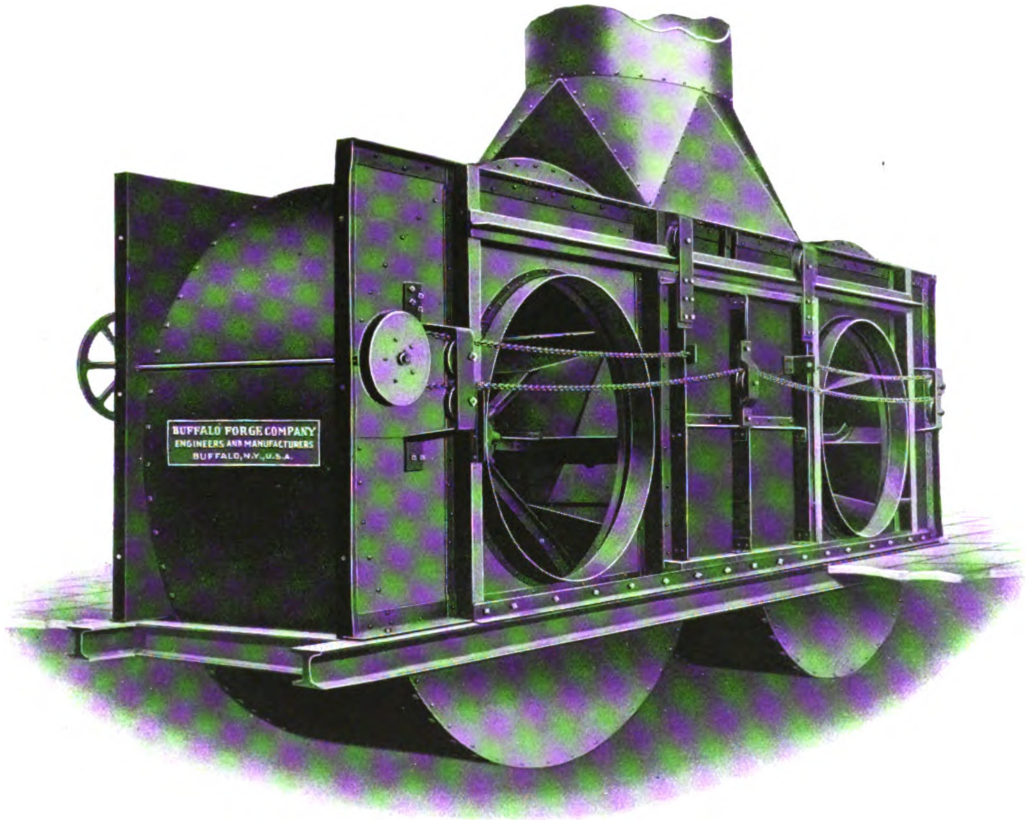
Many extensive mechanical draft and fuel economizer plants are now in operation, or in process of construction in various parts of the country. Data from the later outfits show a continued increase in economy over earlier plants. Briefly let us enumerate the chief points attendant upon the use of mechanical and natural draft.

CHIMNEY DRAFT.—First, Enormous waste of heat from unutilized escaping flue gases. Second, Excessive first cost compared with that of properly designed fans. Third, Variable efficiency, contingent with atmospheric conditions. Fourth, Inability to provide for increased capacity. Fifth, Difficulty of regulating draft for varying requirements. Sixth, Inefficient use of low grades of coal. Seventh, Attendant smoke nuisance using bituminous coal. Practically the only good point the chimney possesses is its comparative freedom from cost of maintenance—a minor item, not always absent.

MECHANICAL DRAFT.—First, Highest utilization of heat from flue gases, made possible by the improved forms of economizers. Second, Low first cost compared with a chimney of usual dimensions for a given battery of boilers. Third, Positive efficiency wholly unaffected by atmospheric conditions at all times. Fourth, Ample provision for large future capacity. Fifth, Perfect regulation of draft for sudden increased or decreased requirements. Sixth, Complete combustion of low grades of coal attended with great reduction in fuel bills. Seventh, Practical elimination of the smoke nuisance, using a certain mixture of hard and soft coals. Eighth, Increased steam power of boilers, thereby guarding against impaired capacity during temporary repairs to a portion of the boiler plant. Ninth, The small cost of maintenance, an item which is far less than the interest on the increased first cost of a chimney for natural draft.

Buffalo Mechanical Draft Apparatus

Horizontal Tandem Arrangement for Induced Draft



Full-Housing Fans of the Three-quarter Type Showing Inlets and Sliding Damper

Buffalo Mechanical Draft Apparatus

Buffalo Fans Applied for Mechanical Draft—Continued

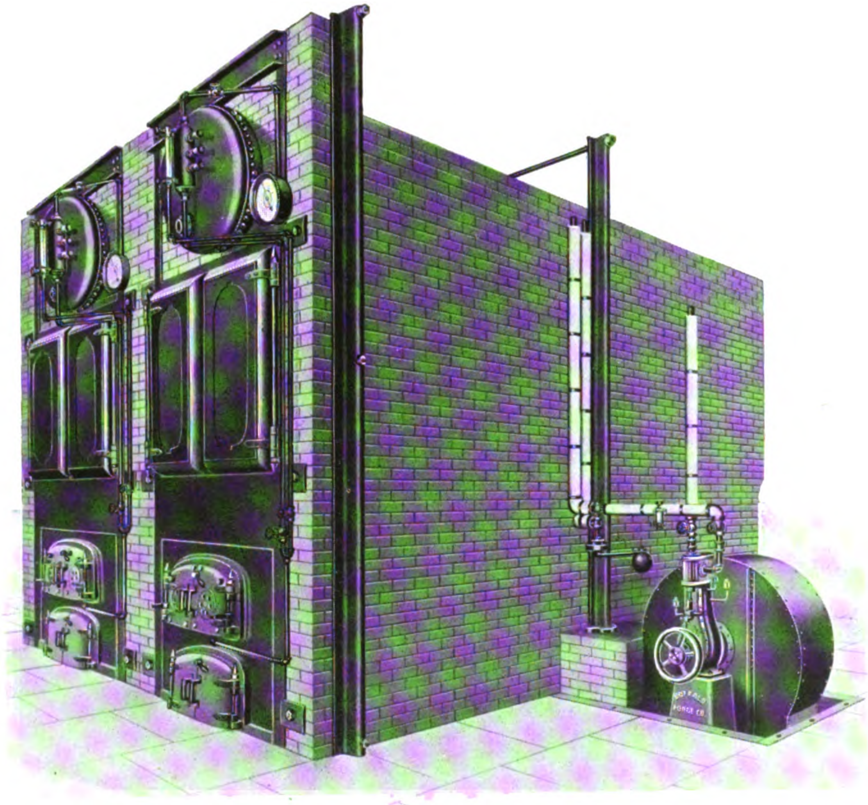
A Careful Résumé of the authentic data published separately will at once clearly verify the above points, and we invite careful investigation of the Buffalo mechanical draft plants from engineers or corporations contemplating increasing or improving existing boiler plants, or the erection of new ones. The foremost consideration is economy, and this, with other features combined, producing the highest available efficiency and superiority, is invariably found in the outfits placed by this house. Original application details, derived from careful tests of extended experience, coupled with the coöperation of manufacturers of the most advanced forms of economizers, have resulted in obtaining results of the highest order. Attention is called to the fallacy of allowing first cost to be the deciding feature in placing contracts for this work. Too many examples today show the error of such purchases, where fans of inadequate size have been installed at reduced initial cost, attended with frequent expense for repairs, and, what is worse, the annoyance of impaired capacity during such periods. The provision for future needs has also thereby been eliminated. That the character of Buffalo fans and engines, and the facilities for producing and installing them for mechanical draft are premier, is clearly shown by the large number in use and the unquestionably superior results obtained therefrom.

Buffalo Steel Plate Fans for mechanical draft are special throughout in construction. Duplicate fans are usually employed and so placed that the flue gases may readily pass through either separately or both at the same time, this feature being secured by means of suitable dampers. Reference to the engravings will show several forms of dampers adapted to the various arrangements of fans. The fans are of steel plate, heavily braced with angle and "T" irons, the entire construction being such that the direct heat of the flue gases passing through the fans when the economizer is disabled or at other times will cause no distortion by reason of expansion. The fan wheels are invariably overhung, unless otherwise ordered, with the bearings next to the fan provided with special water-cooling boxes suitable for a flow of water at city pressure, without leakage. The various types of single and double engines described in our engine catalogue are employed. An extra pulley is often provided for the driving of scraper gear in connection with economizers or for other purposes.

In addition to the various designs of single and double engines herein described, Buffalo Steel Plate Steam Fans for Mechanical Draft are also furnished with double upright enclosed engines, cylinders above the shaft. The varying speed required of these engines may be obtained automatically. Photographs and drawings of such construction will be supplied to prospective customers when desired, and for such cases as the use of this form is especially adapted. In passing, it may be mentioned that this engine is precisely the same as has been furnished by this house for the United States Government torpedo boats and battle ships. Continuous running without cessation is one of the first requirements of such service, and is a factor which commends this style of engine for use in plants where duplicate fans are not installed.

Buffalo Mechanical Draft Apparatus

Full-Housing Steam Fan Employed for Forced Draft



Forced Draft Plant at Goulds Manufacturing Company, Seneca Falls, N. Y.

Buffalo Mechanical Draft Apparatus

Buffalo Fans Applied for Forced Draft

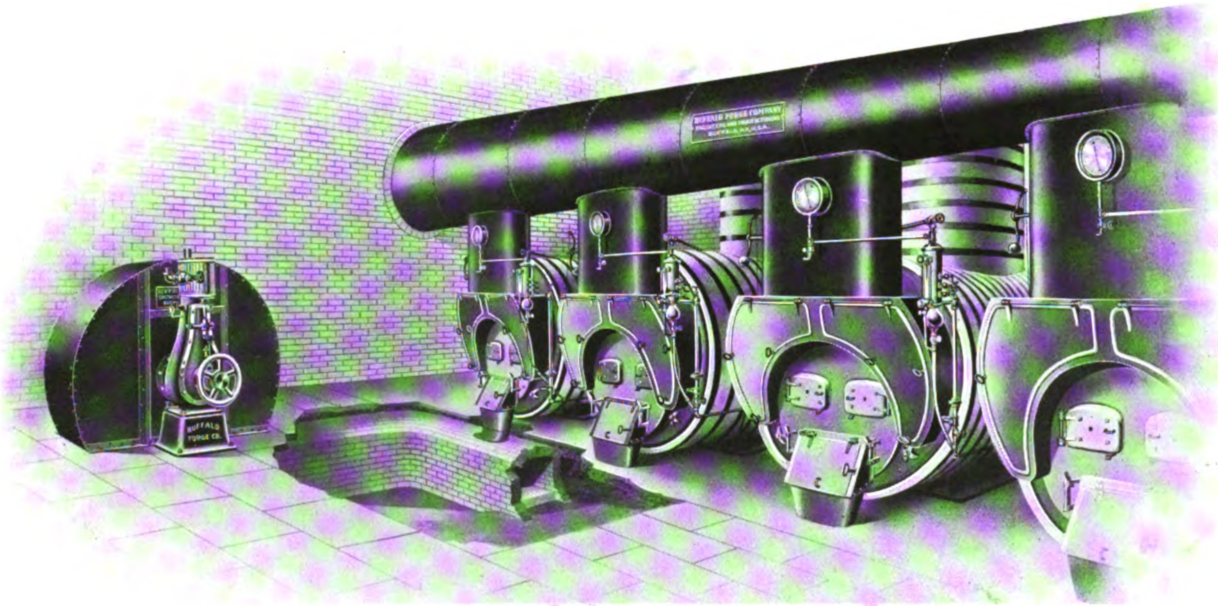
FORCED DRAFT has been used for years, the original installations being principally for burning refuse materials, and for assisting boiler draft of natural low efficiency. The advancement to popular favor has been of healthy but gradual growth. In the early stage, it was commonly supposed that what would now be called in mechanical draft a high air pressure was absolutely essential to best results. As this type of mechanical draft has developed, it is noticeable that in succeeding representative plants the velocity of air has gradually decreased, until now it is generally recognized that forced draft outfits show the best results where a sufficient air volume is used at the lowest pressure which secures complete combustion. Practice has established the fact that this is more economical than using the same quantity of air at double the velocity, because of less liability to blow holes, less unconsumed particles carried up the stack and less horse power consumed by the fan.

As is at once understood, the term "forced draft" used in connection with a steam plant refers to the forcing of the air under the grates. The favorite point of introduction into most boilers is through the bridge wall at the rear end of the grates. Where this arrangement is not feasible, however, quite as efficient results are obtained through side walls, or further in front, using properly arranged dampers with convenient accessories for manipulation. The first blowers supplied for forced draft and those now most widely used in small plants, also where refuse material such as bagasse, etc., is consumed, were the Buffalo "B" Volume Type, described further on, having cast-iron shells, designed for the heaviest service and capable of delivering air at high pressures. A number of special patented grates designed for forced draft, which are largely of the hollow-blast type and require a blower in connection, have been introduced with considerable success. For all advanced forms of these the Buffalo Steel Pressure or "B" Volume Blowers are peculiarly fitted, and are therefore employed by manufacturers and users of such devices. The more complete steam plants of today are equipped with mechanical stokers. In connection with stokers of the underfeed type, which require high air pressure, the Buffalo "B" Blowers have been generally adopted by those seeking durability and results of highest order. For forced draft outfits of more important size, also where coal is burned, either of high or low grades, the Buffalo Steel Plate Fans are generally used, and for this work are rigidly stayed and stiffened. In some cases they are built narrower than the standard type, with a wheel of relatively large diameter, to give high peripheral velocity at moderate speed.

DIRECT ADVANTAGES exist in favor of forced draft where certain conditions exist. The chimney of a given steam plant may be capable of handling the boilers excepting under adverse conditions of weather, when a blower properly applied needs only to be started and run during such periods. While the capacity of a chimney, either with forced or natural draft, is limited, the natural efficiency may be materially increased, so that if more boilers have been added than the chimney will properly handle without some assistance, this may be afforded by the proper application of a blower to force air into the ash-pit.

Buffalo Mechanical Draft Apparatus

Three-quarter Housing Steam Fan Applied for Forced Draft



Application to Scotch Marine Boilers at Waterloo Woolen Mills, Waterloo, N. Y.

Buffalo Fans Applied for Forced Draft—Continued

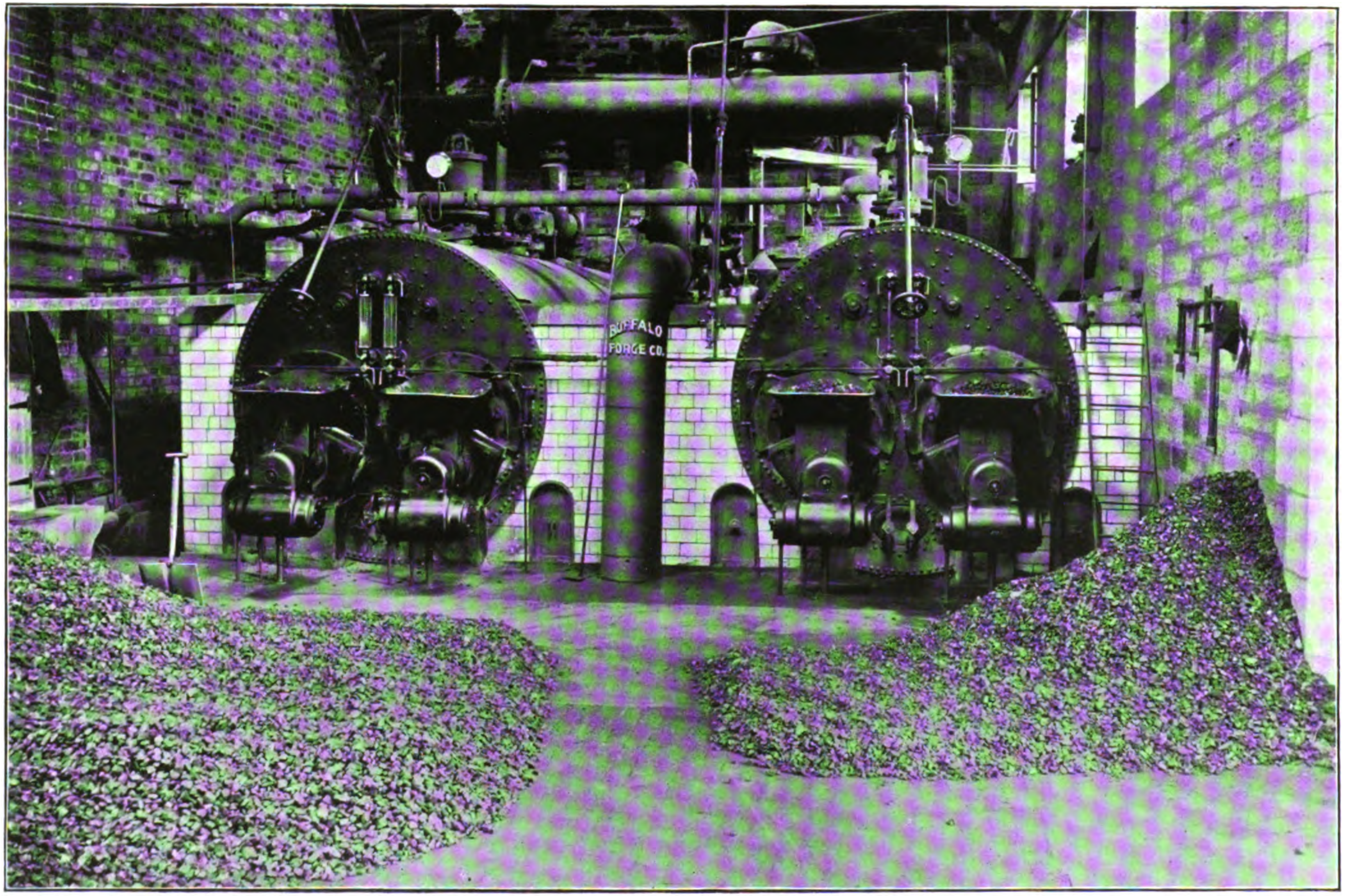
FORCED DRAFT is especially valuable in the burning of screenings or low grades of fuel. It is here that direct application of draft to the boiler grates affords immediate and positive results. Throughout the anthracite coal sections, and at shipping points where there is a large accumulation of culm or screenings, many Buffalo Forced Draft plants in operation for years are today forcible examples of economy and efficiency. The pioneer outfits were installed by this house, also all valuable and approved devices relating to application and regulation features since perfected were likewise originated. The smoke nuisance in cities where a portion of hard and soft coal is available, be it in the form of screenings or higher grades, is at once solved by the Buffalo Forced Draft System. The proportion which secures the best and hottest fire is 75 per cent. of anthracite and 25 per cent. of soft coal. With this mixture, smoke is practically eliminated and steam plants thus operated come entirely within the limit of city ordinances. The proportion of this mixture has little to do with the efficiency of a forced draft apparatus, and, intelligently installed, excellent service will be obtained burning entirely anthracite or soft coal, or a mixture of different proportions.

OCCASIONALLY OBJECTIONS to forced draft are urgèd, on the ground that with its use there is an outward leakage of gases and blow holes through boiler fires at different grate intervals. Such results only occur with poor applications and installation details, or with improper firing. The method of introduction of the air to the grates and the appliances therefor, figure conspicuously in the securing of maximum economy and efficiency, and attention is called herewith to the illustrations on page 64 of the various forms of cast-iron dampers patented by this house. Where the air supply to the fan is taken from an air chamber built around or through the smoke breeching—and herein is embodied an important saving—the temperature of the air supply and consequently the temperature of the furnace is raised while the temperature of the gases in the breeching is reduced. With natural draft this would tend to reduce the velocity in the stack. It is highly desirable that the fan be driven by an individual engine, with the valve controlling the steam supply thereto equipped with the special arrangement for governing the speed of the engine, according to the draft requirements. In brief, the principle of this consists of automatically supplying more steam to the engine when the boiler pressure lowers and less steam when the steam pressure increases. This has been brought to so fine a point that practically a constant pressure is maintained on the boilers with proper firing.

BUFFALO FORCED DRAFT PLANTS have been in successful operation for a period of years with no unusual repairs, and in many cases have shown a net saving of 30 per cent. in fuel bills with a relative gain in efficiency of 10 to 15 per cent., also practically abolishing the smoke nuisance. This exceptional record arises from the fact that before the introduction of the forced draft system the higher grades of coal were burned, while afterward hard coal, such as buckwheat, rice, and soft slack coal were consumed.

Buffalo Mechanical Draft Apparatus

Boilers Equipped with Forced Draft and Mechanical Stokers



Scottish Co-operative Wholesale Society's Junction Mills Work, Leith

Buffalo Mechanical Draft Apparatus

Buffalo Fans Applied for Forced Draft—Continued

Mechanical Forced Draft is now generally adopted for all large and important boats, and also for many of the smaller ones. Induced draft is used occasionally, and is growing in favor; the more common type in marine work, however, is forced draft. The closed stoke-hold system, *i. e.*, blowing the air into an inclosed boiler room, is widely used. Air is also introduced beneath the grates with a special arrangement of air-tight ash-pit doors and dampers, so connected that the draft is shut off when the doors are opened for firing. Owing to the small space available in marine work, direct-attached engines are employed with the fan construction and all other details arranged to occupy minimum space, all installations being special to suit the peculiar conditions of each boat (see illustration of fans built for U. S. Revenue Cutters on page 40). Mechanical draft plants are employed on shipboard to produce very high rates of combustion and an intensity of draft that would require a chimney three or more hundred feet in height.

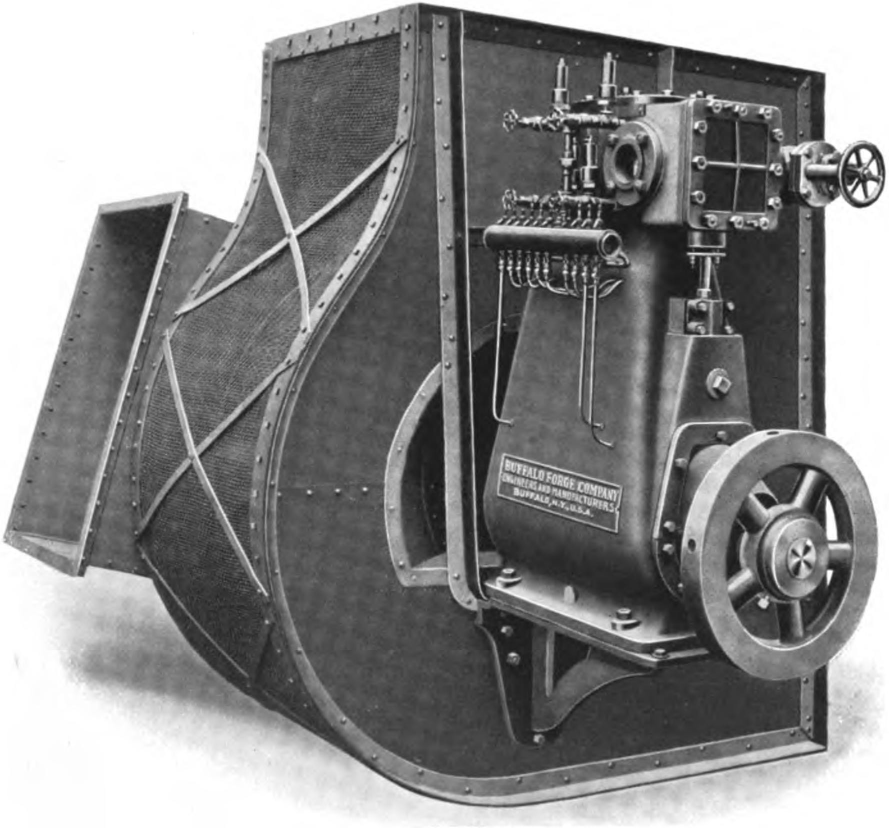
It is impossible to present herewith engravings which would illustrate comprehensively the manner of application of forced draft to marine boilers, but those intending to equip boats, large or small, are requested to send for complete drawings of plants in ships of similar size, which will be cheerfully furnished. They will give very clear ideas as to ordinary arrangements. Correspondence should be accompanied with a statement as to the number and size of boilers, steam pressure carried, space available for fans, and, if possible, a sketch showing desired relative position with reference to the grates of the furnaces. The heat of the boiler and engine rooms of many merchant marines is unbearable, but may be at once relieved by the same fan which is introduced for forced draft, by providing in the application to receive the source of air supply from that portion of the boat. Other parts of the vessel requiring ventilation may be readily accommodated where it is feasible to connect same to the fan by means of galvanized iron conduits. Forced draft was primarily used on shipboard to the end of securing increased speed, and without any reference whatever to economy, increased steaming capacity of boilers, ventilation of the fire-rooms, closets, or other portions of the boat. These points are now considered and usually properly treated in the installation of mechanical draft plants of modern boats.

Induced Draft on Shipboard is equally as efficient as forced draft in the matter of speed and steaming capacity of boilers, but by reason of the necessity of drawing air to the boiler grates through the fire-room, the other portions of the boat cannot be as readily ventilated with the same fan.

The engraving appearing on page 36 clearly illustrates the ordinary arrangement of a forced draft system to a battery of stationary boilers of the marine type, the fan shown being of the three-quarter housing type, and communicating direct to the fires through an underground duct. The illustration on page 34 shows the method of introducing air through the bridge-wall into closed ash pits, while the reproduced photograph on page 38 illustrates the method of introducing air through underground ducts. Either method gives entire satisfaction.

Buffalo Mechanical Draft Apparatus

Type of Apparatus Used on U. S. Revenue Cutters



Fan Employed to Obtain Both Forced Draft and Ship Ventilation.

Buffalo Mechanical Draft Apparatus

Buffalo Fans Applied for Forced Draft—Continued

Central Heating and Lighting Stations in the great cities are generally situated where economy of room is of paramount importance. This creates the necessity of obtaining a maximum steaming capacity in a minimum space. Of so great consequence is this point that the cost of the equipment which will show the best results is of little moment. Limitations of space often necessitate the suspension of fans from ceilings, also special construction, but all such requirements can usually be met to a nicety. It is in certain important work of this nature that the forced system of mechanical draft using Buffalo fans has been employed, obtaining a boiler capacity within a limited space impossible to secure by natural draft under the most favorable conditions, at the same time close economy of fuel.

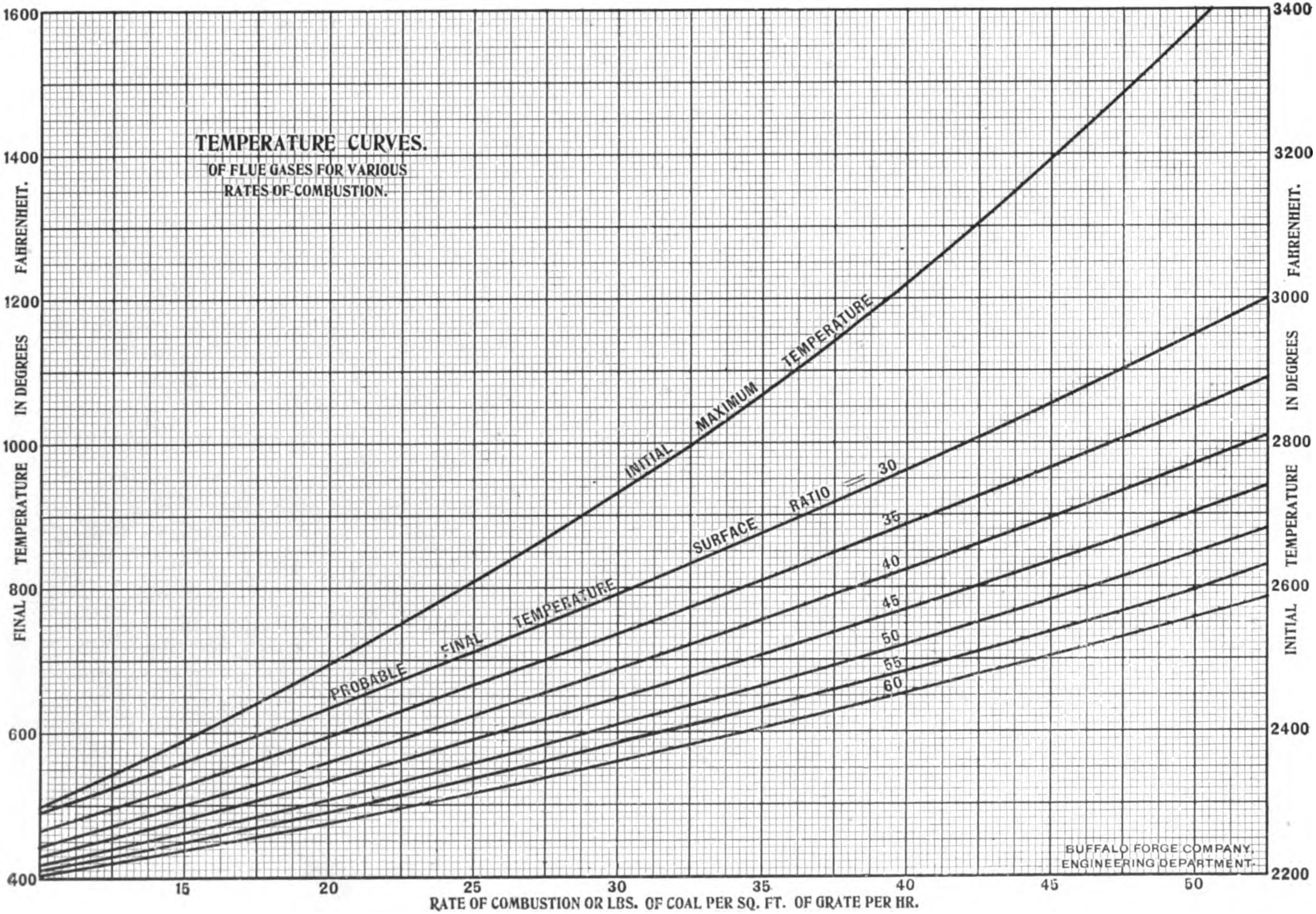
Combined Induced and Forced Draft applied to a battery of boilers is somewhat unusual, but the Buffalo Special Steel Plate Fans have been thus employed with excellent results. The combined system being employed because of equipping the boilers with stokers, requiring a closed ash pit. Certain special boilers are designed particularly for induced and forced draft, and to these have applications been made, with the result of obtaining more than a regular amount of steaming capacity within a given space. Ordinary boilers have also been thus outfitted with considerably increased capacity.

The combination may be installed in two ways, as follows: First, With two separate fans, one an induction and the other an eduction fan. Second, With a single fan of special construction, having a web or divided wheel and two inlets, one to receive the intake of gases from the boiler stack, and the other to receive fresh air, the amount handled being regulated by an oscillating damper. The former arrangement is necessitated for the special boiler construction alluded to, and is also applicable to large steam plants with ordinary water tube or tubular boilers with or without equipments of economizers and burning fuel of low grades. The fan for forcing air under the grates is usually somewhat the smaller of the two.

The more simple plants of combined induced and forced draft employ the one fan arrangement, which is built with two inlets and takes in unheated air on one side. Connection, by means of a suitable pipe, is made with the chimney flue or smoke breeching of the boiler to the other side of the fan, thereby taking in the larger part of the flue gases. These are mixed with the fresh air taken in from the other side of the fan as it leaves the outlet and is being delivered to the ash-pit of the furnaces. From thence the air is forced through the grates to the fuel bed. Dampers are used on each side to regulate the proportion of air and flue gases admitted to the fan. Recently published tests of such apparatus using Buffalo Special Steel Plate Fans, show an average temperature of the air discharged under the grates of 235 degrees, and naturally a great gain in efficiency over the same boilers without the device. When using the fan, but not heating the air supply, the increase also demonstrated the value of the outfit. In both cases the smoke reduction was very marked.

Buffalo Mechanical Draft Apparatus

Temperature Curves—Plate I



Buffalo Mechanical Draft Apparatus

Economy Effected in Power Plants

HIGHEST ECONOMY from boilers, engines, and dynamos, as is well understood by engineers, can be obtained only when they are run under a steady load at their rated capacity. In instances such as the performance of ocean steamers and pumping stations when the above conditions exist, the theoretical efficiencies are often closely approached. On the other hand, in plants having very irregular duty as many manufactories and electric light and electric railway plants, it is common to find the amount of coal required per horse-power hour instead of being from two or three pounds as in the above cases, to reach, even with compound engines and condensers, from five to as high as seven pounds.

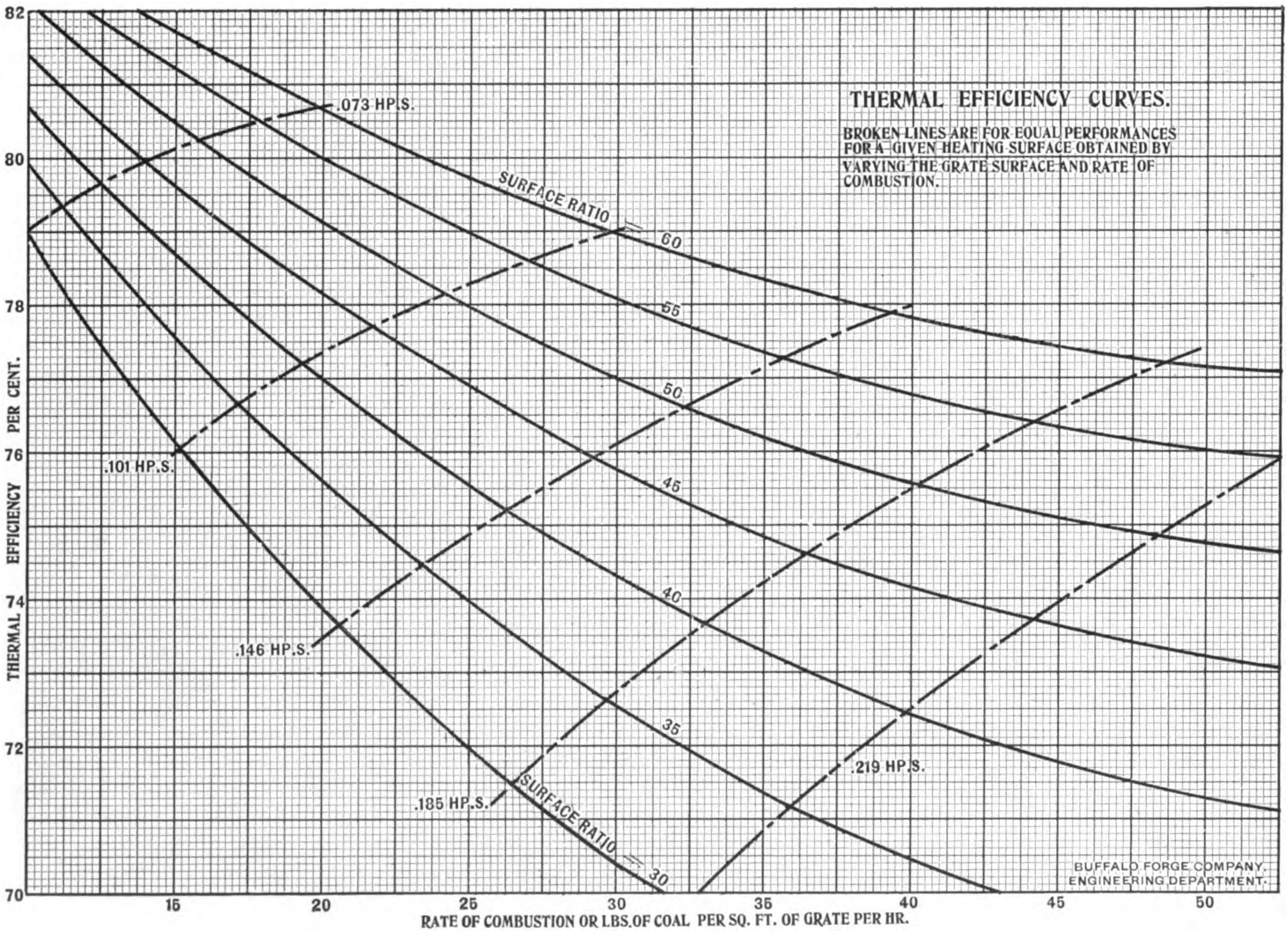
CAUSE OF LOW EFFICIENCIES.—Looking for the cause of these low efficiencies, we find that the entire plant equipment is of necessity designed to meet the higher requirements of power at the peak loads. The efficiencies of the engines, dynamos and boilers at the average and low loads are then much under the normal efficiencies at their rated capacities. Not only is the cost of coal great, but the interest on the cost of the plant and cost of maintenance, relative to the output of power, are correspondingly large. The increase in cost of operation at low average loads, in the case of boilers, is well shown by the curves, Plates III and IV, which are explained further on. It is in such cases that the economic advantage of a highly flexible means of regulating the boiler draft is most strikingly shown. It has been found that by increasing the intensity of combustion, the boiler performance may be greatly increased without materially lowering the efficiency. This, as has been stated, is due to the more perfect utilization of the air supply, and a consequent increased initial temperature, a smaller relative quantity of gas, and therefore a more efficient transfer of heat and a much smaller loss of heat units in the flue gas relative to its temperature.

PROBABLE TEMPERATURES that may be obtained and the resultant thermal efficiencies are shown by the curves in Plates I and II, for various surface ratios and rates of combustion. The horizontal spaces, Plate I, represent the rate of combustion in pounds of coal per hour per square foot of grate surface, while the temperatures are represented by the vertical spaces. The curve marked "Initial Temperature" shows the maximum temperature of the products of combustion corresponding approximately in practice to a given rate of combustion. The curves marked "Probable Final Temperature" shows the approximate final temperature of flue gases which should be obtained when the boiler is in good condition. These curves are given for the usual surface ratios (*i. e.*, ratio of heating surface to grate surface) between 30 and 60. Both initial and final temperatures are dependent directly upon the relative air supply per pound of coal, which in turn is dependent upon the rate of combustion. Higher rates of combustion, with proper firing, decrease the relative air supply proportionally.

In Plate II the curves of thermal efficiencies are shown for the corresponding surface ratios and rates of combustion. The thermal efficiencies are represented by the vertical spaces and the rates of combustion by

Buffalo Mechanical Draft Apparatus

Thermal Efficiency Curves—Plate II



Economy Effected in Power Plants—Continued

the horizontal spaces as in the preceding case. The curves in broken lines marked ".073 H. P. x S.," ".101 H. P. x S.," etc., are for equal performances obtained by varying the surface ratio and the rate of combustion, and indicate that for a given condition, .073 B. H. P. or .101 B. H. P. (etc., as the case may be) multiplied by the total heating surface in square feet is the actual horse-power performance of the boiler under the given conditions.

Effect of Increased Rate of Combustion.—To show the increase in efficiency that may be obtained by decreasing the amount of grate surface and increasing the rate of combustion correspondingly, for example, take a boiler having a ratio of heating surface to grate surface of 30, which at a rate of combustion of 21 pounds of coal per hour per square foot of grate surface will give a performance of .146 B. H. P. for each square foot of grate surface at a thermal efficiency of 73.6 per cent. Now, if the grate surface be decreased one-half, we will have a surface ratio of 60. To obtain the same performance of heating surface, we must maintain a rate of combustion of 35.9 pounds of coal per hour per square foot of grate, which should give us under average conditions an efficiency of 77.9 per cent. or an increase in efficiency of 4.3 per cent. As a more striking illustration, take a boiler with a surface ratio of 30, which should give under proper working conditions a thermal efficiency of 76.5 per cent. at a rate of combustion of 15 pounds of coal per hour per square foot of grate surface, and a performance of .10 B. H. P. per square foot of heating surface. Let the grate surface be decreased to give a surface ratio of 46, then by increasing the rate of combustion to 30, we shall have increased the capacity of the boiler 46 per cent. without having decreased its efficiency.

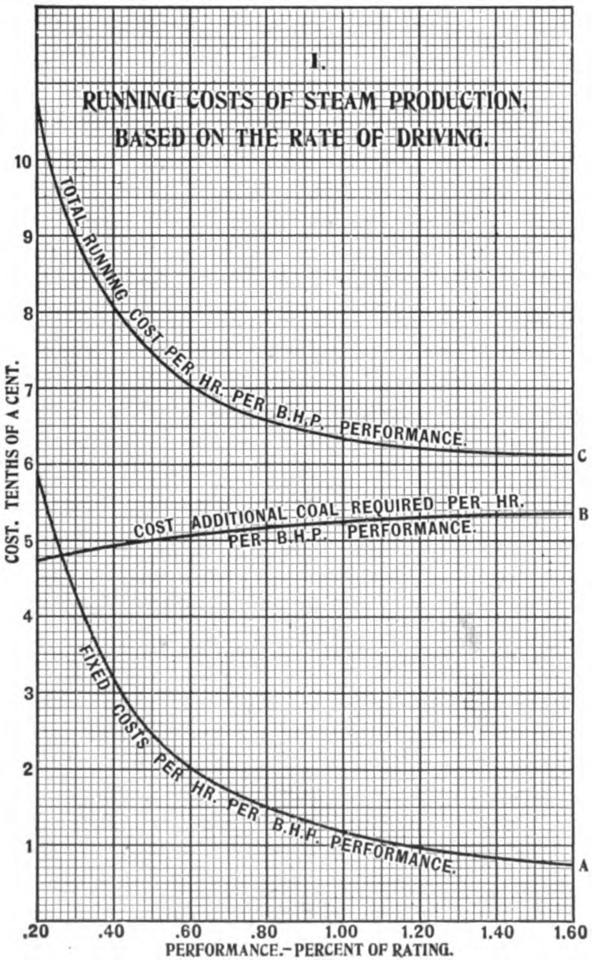
Basis of Calculation.—Curves, Plate III, show the running of cost per hour per horse-power performance for various rates of driving in per cent. of the rated capacity, and are based on the following assumptions:

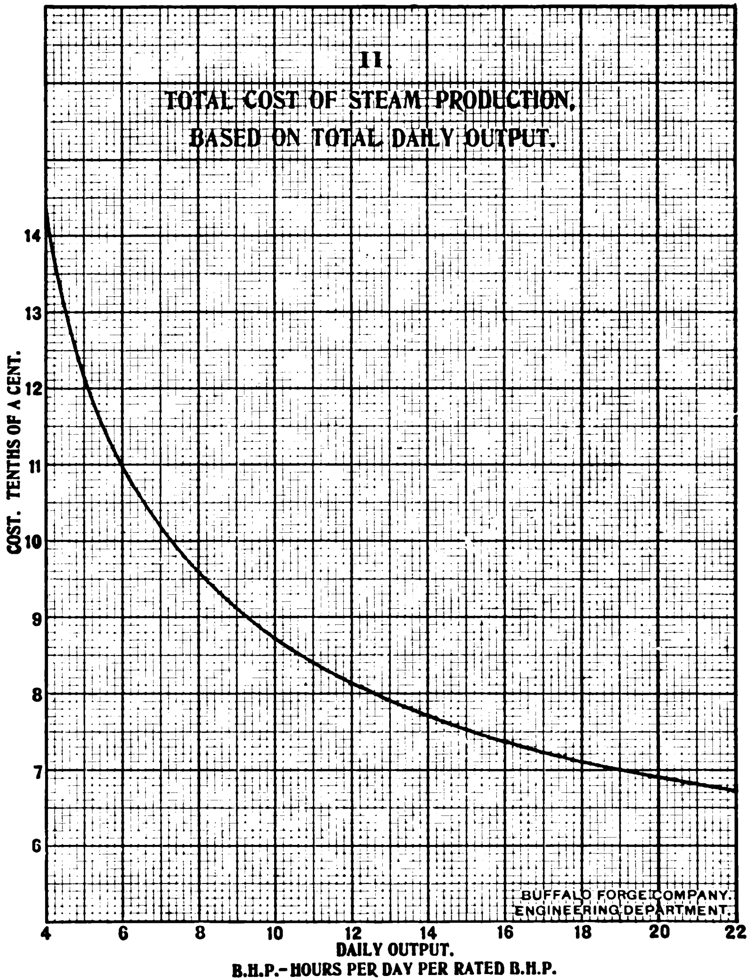
Cost of coal, ...	$3.00 per ton at plant.
Cost of labor, ...	$2.50 per day.
Cost of boiler plant, ...	$25.00 per rated horse power.
Cost of maintenance (including deterioration),	7½ per cent.
Interest, ...	5 per cent.
Heat generated per lb. coal, ...	12,500 B. T. U.

One boiler horse power is taken as equivalent to the evaporation of 34½ pounds of water from and at 212° F. per hour. Although builders' ratings vary, with a ratio of heating surface to grate surface of 45 to 1, we may take as an average rating 11.5 square feet of heating surface per rated horse power, which corresponds approximately to a rate of combustion of twenty pounds of coal per hour per square foot of grate. It is assumed that the radiation loss is constant for all rates of driving, although this is not strictly accurate, yet the increase in radiation loss with increased rate of driving is relatively so slight that it may be neglected.

Buffalo Mechanical Draft Apparatus

Cost Curves—Plates III and IV





Economy Effected in Power Plants—Continued

Under ordinary conditions the radiation loss is about 12 per cent. of the rated performance. It requires, then, to compensate for it, approximately one-half of a pound of coal per hour per rated horse power.

From these assumptions the following constant hourly costs per rated horse power are computed:

Interest and maintenance,	$.00033
Labor,	.00022
Radiation loss,	.00065
Total fixed cost per hour per rated horse power,	$.00120

Total fixed hourly cost divided by rate of actual performance to rated performance gives curve marked "Fixed cost per hour per boiler horse-power performance."

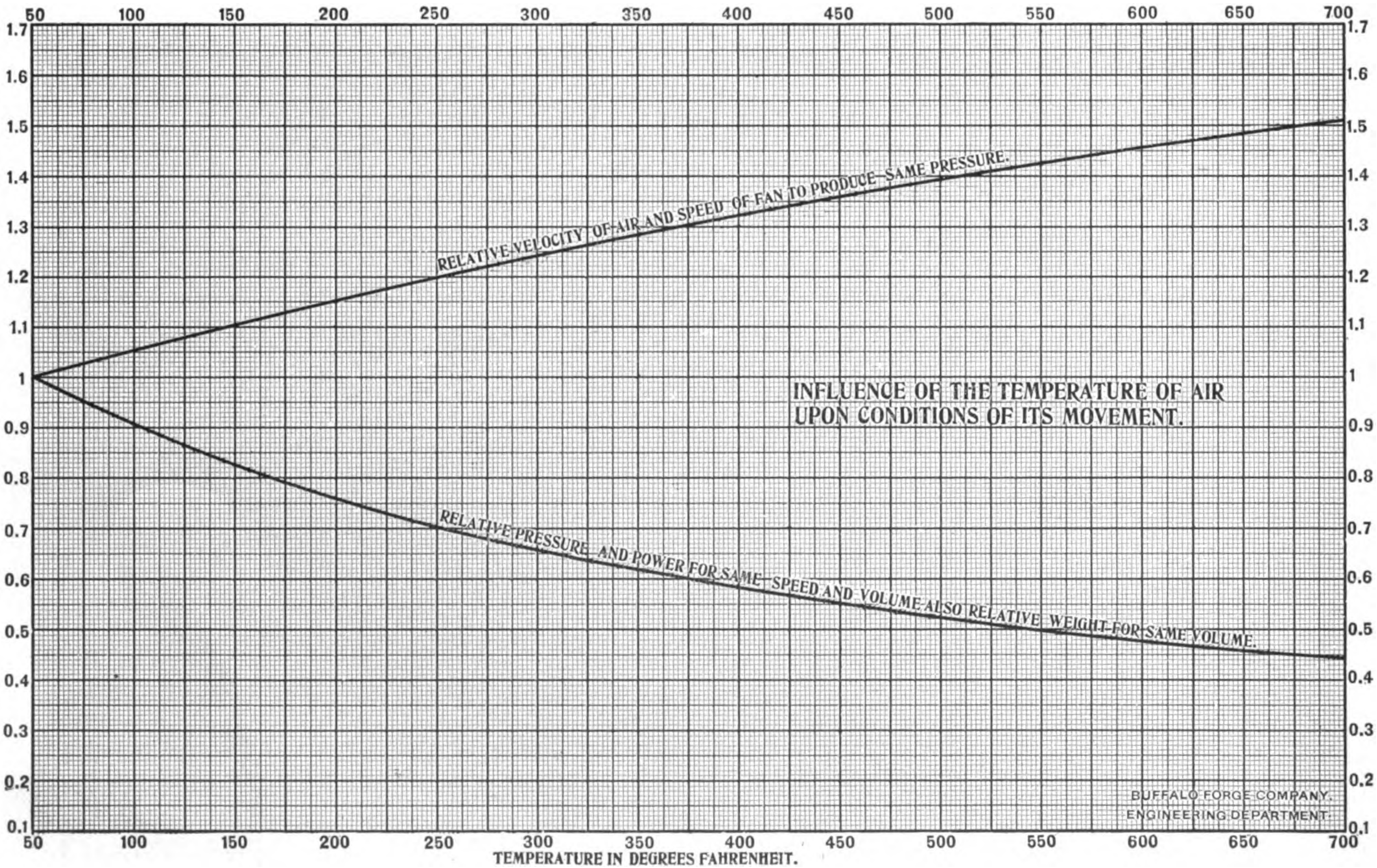
High Rates of Driving.—Knowing approximately the thermal efficiencies at the different rates of driving, we have the means of obtaining the cost, curve "B". We see that although "B" increases with increased performance, it does not increase as rapidly as "A" decreases. As the sum of these two curves we have the curve "C", which shows the total cost per hour per horse-power performance to *decrease* slightly when the boilers are driven above their rated performance, and to *increase* very rapidly when driven below this rating, demonstrating the economy of high rates of driving. The curves in Fig. IV shows the cost of the daily work required of the boiler. Estimates are based on 308 working days in the year. The average fixed costs per each working day is the total fixed cost per year divided by 308. In electric light and railway work it would, of course, be for 365 days. If the boiler was worked on an average at its rated performance for ten hours a day its daily output would then be ten horse-power hours per rated horse power. The cost per horse-power hour would be the total daily cost divided by ten. Similarly the costs of other daily outputs are determined. We may see from this curve the considerable advantage of running the plant at an average equal to or above the rated capacity of the boilers.

Defects of Chimney Draft.—The difficulty in accomplishing this with chimney draft is, in the first place, that 20 pounds of coal per square foot of grate is about the maximum rate of combustion obtainable. Second, to run the engine at all economically at the average loads they must be overloaded at the peaks, with simple engine by changing the point of cut-off to nearly full stroke, and with the larger compound and triple expansion engines by admitting high pressure steam into the low pressure cylinders. In either case the water rate of the engine is greatly increased.

Thus, not only are the boilers called upon to supply more engine horse power, but they must also furnish one-fourth to one-third more steam per engine horse power. Fifty per cent. overload on the engine will, therefore, require nearly *two times* as much steam as at normal running. As every fireman knows, there

Buffalo Mechanical Draft Apparatus

Influence of the Temperature of Air—Plate V



Economy Effected in Power Plants—Continued

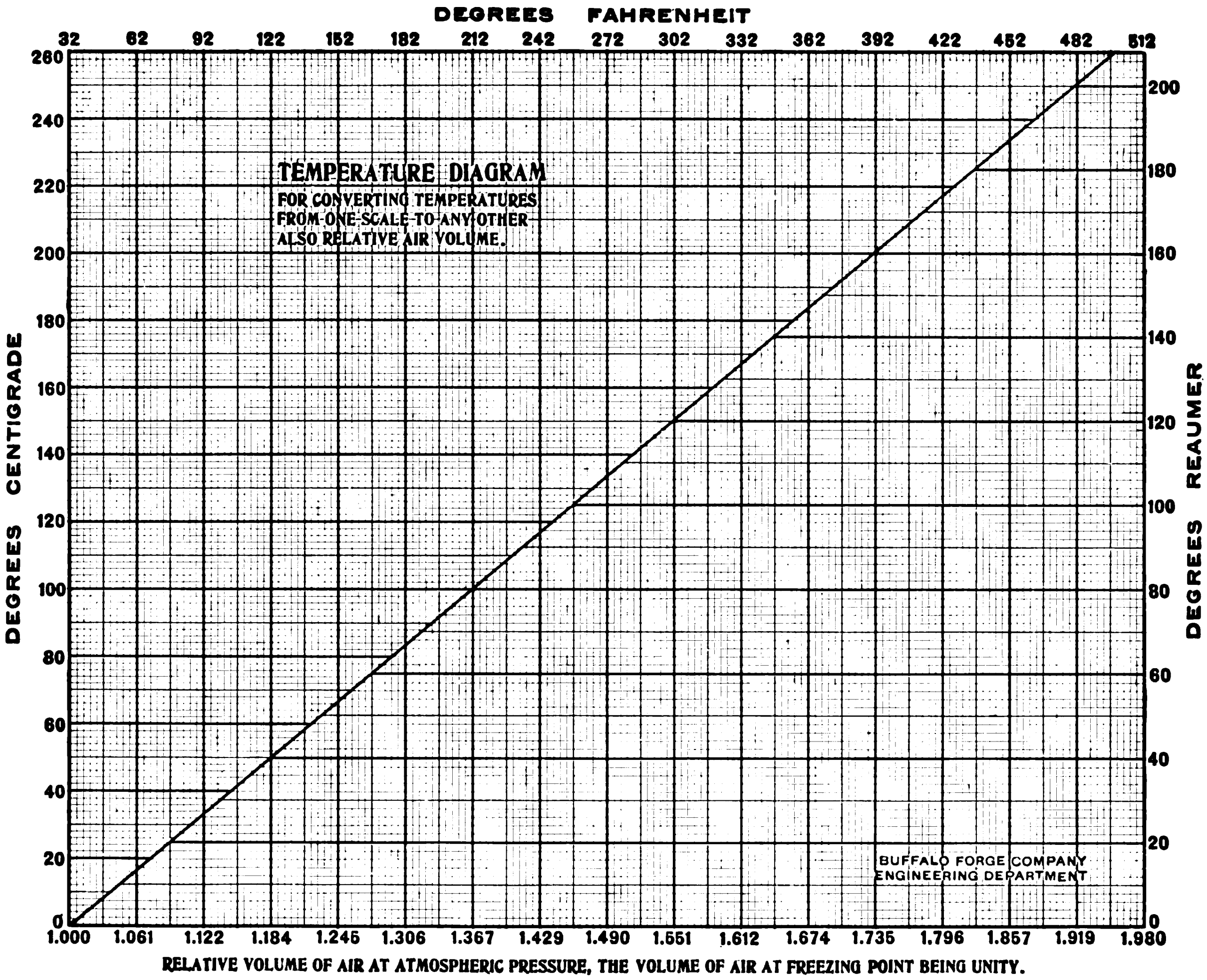
is always great danger, too, with chimney draft, when the atmospheric conditions are unfavorable, or with slight negligence in firing, that sufficient steam will not be made at the peaks to maintain the pressure. When this happens it becomes impossible to bring the pressure up again, since the engines demand more steam at the lower pressures; and the pressure continues to fall until the plant is brought to a standstill. With ordinary chimney draft it is manifestly impossible, where there are fluctuations of 50 per cent. in the load, to run the boilers on the average loads with a rate of combustion much over ten pounds of coal per square foot of grate, since the maximum rate of twenty pounds is required at the peaks.

Flexibility Essential.—With mechanical draft the rate of combustion can be easily increased to over 50 pounds of coal per square foot of grate, driving the boiler at more than double its rated capacity with fair economy. Of course, it should be understood, that such high rates of driving are possible, even for short periods, only where the boilers are in the best condition, with ample heating surfaces free from incrustation, and designed to withstand high temperatures. Further, it is imperative that the thickness of bed of fuel be proportioned to the intensity of draught, otherwise no advantage is derived from the increased rate of combustion. The boilers may, therefore, be run at the average loads at a rate equal to or above their rated capacity. Besides, with the better facilities of draft, economizers may be placed in the smoke flues. These greatly aid the boilers in the performance of their work, especially at the peak loads, saves the cost of increased boiler power, and gives considerable economy in fuel as well.

A Practical Illustration.—In such cases as the above, when with mechanical draft we could obtain a daily output of over ten horse-power hours per rated boiler horse power, we could obtain only one-half as much, or only *five* horse-power hours, with natural draft of ordinary intensity. Now, referring to the cost, curve, Plate IV, we see that the cost of the production of steam per horse-power hour is $.01215, at a daily output of *five* horse-power hours per rated horse power with natural draft, while with mechanical draft at *ten* horse-power hours output the cost is only $.00830, giving a difference of $.00385 in cost per horse-power hour. Under these conditions in a boiler plant having an average output of 1,000 horse power, or a total daily output of 10,000 horse-power hours, the saving would be $38.50 per day, or 308 times $38.50, which equals $11,858 per year saved by using higher intensities of draft. With economizers the saving would be about 12 per cent. greater. The cost of operating the induced draft fans may be figured at 1½ per cent. of the total cost of plant operation as a fair average, since from one to one and one-half per cent. of the boiler power is used by the fan engine. On this basis the cost of operating the fans would be one and one-half per cent. of 308 times $83.00, which equals one and one-half per cent. of $24,364, or $365 per year. This gives a net saving of $11,858 less $365 or $11,493 per year, which is equivalent to a saving of $11.50 per horse power per year.

Buffalo Mechanical Draft Apparatus

Temperature Diagram—Plate VI



Buffalo Mechanical Draft Apparatus

Economy Effected in Power Plants—Continued

In addition to the savings just enumerated and tabulated below, the following are worthy of much consideration. With economizer capacity sufficient to heat the feed-water from 65° to 200° the saving in fuel will be 12 per cent. In a 1,000 horse-power plant, this would amount to an additional yearly saving of $2,130 or $2.13 per horse power per year, with fuel costing $17.80 per horse power per year. It is estimated that the first costs of a plant and the cost of maintenance will not be materially increased by the use of economizers, since by heating the feed-water they increase the capacity of the boilers from 8 to 12 per cent.

COMPARATIVE COSTS OF BOILER PLANT OPERATION ON PEAK LOADS, USING NATURAL AND MECHANICAL DRAFT.

1.	Cost per boiler horse power hour at one-half rated daily output,	$ .01215	......
2.	" " " " " " " full " " "	.00830	....
3.	Saving " " " " " " " " " "	....	$ .00385
4.	Cost per day of 1,000 horse power at one-half " " "	121.50	....
5.	" " " " " " " " full " " "	83.00	....
6.	Saving " " on " " " " " " " "	....	38.50
7.	Cost " year of " " " " one-half " " "	37,422.00	....
8.	" " " " " " " " full " " "	25,564.00	....
9.	Saving " " " " " " " " " " "	....	11,858.00
10.	Cost of operating induced draft fans one and one-half per cent.	....	385.00
11.	Net economy per 1,000 horse power yearly, with mechanical draft,	11,493.00	....
12.	" " " " " " " " "	11.50	....
13.	Per cent. economy, ... " " "	31 per cent.	

To Correspondents: In order to give specific data concerning projected mechanical draft plants, it is essential that we be furnished with the following details:

First, Number of boilers to be served, also the name of the manufacturer of each, and its rated boiler horse power. Second, The width, length and square feet of grate area of each. Third, Kind and quantity of fuel to be burned. Fourth, Steam pressure to be carried. Fifth, Motive power preferred for fan, *i. e.*, steam or electricity, with belted or direct-connected rig. Sixth, Whether automatic regulator for governing speed of fan according to boiler pressure is desired. Seventh, Fully dimensioned sketch showing proposed location of fan relative to the boilers and stack. Eighth, Clear available space above the boiler settings. Ninth, Is stack built or to be built of steel or brick? If already built, give height and area of smallest cross-section, and state whether square or round. Tenth, Do you prefer forced or induced draft?

Buffalo Mechanical Draft Apparatus

Horizontal Tandem Full-Housing Fans of Three-quarter Type

View showing Lever and Hand Wheel by means of which either Fan may be cut off

Buffalo Mechanical Draft Apparatus

Arguments in Favor

First Cost.—As a consideration which, though ultimately a secondary one, is first brought to the attention of the interested party, it is well to compare the expense of installation for each one of the three mechanical draft types as against the chimney. An examination of our records, with estimates made from them, confirms various published reports which show that with a boiler plant of average size the cost of a forced draft fan, engine and stack is about 20 per cent. of the outlay required for the construction of a chimney which would take care of a boiler plant of equal boiler horse power.

The single fan induced draft plant, which has at its maximum double the capacity of the forced draft fan required for the same boiler horse power, is 30 to 40 per cent., and the double fan outfit, complete with smoke connections, dampers, and a short stack, less than 50 per cent. of the cost for a natural draft equipment. The double fan induced draft set is most complete, and usually installed in connection with economizers to give the greatest possible gain in efficiency. This type is also universal in mechanical draft plants which are required to operate continuously, where any breakdown, however temporary, would be a great inconvenience. The system is designed so that only one fan is operated at a time, being sufficient to carry the entire load alone. An added advantage is, that for short periods, both fans may be used at once, to force the boilers beyond their rated capacity, as may be necessary in electric light or street car service during a crowded season.

The photograph, reproduced on page twelve, illustrates well the comparative size of stacks for the two systems, having been taken immediately after remodeling the boiler plant at the Osaka Water Works and also increasing the capacity of the original plant, which was served by the brick stack. The new plant being in operation at the time, the photo illustrates the advantage of induced draft as a means of smoke prevention.

In considering the original cost of installation, it may be noted that the chimney requires a heavy, solid foundation, which is in itself no small item. The fan, by virtue of its lightness, requires much less brickwork than a single ordinary boiler setting, and when placed above the boilers, as it frequently is, the cost for erection is a very small per cent. of the foundation required for a chimney.

Cost of Operation.—At first thought it would appear that the chimney has a decided advantage in operating expense, but it will at once be clear that we cannot compare the two directly; we must, on the contrary, consider the boiler plant as a whole, operating under the respective conditions of natural and mechanical draft. This will include interest, taxes, insurance and other fixed charges, beside the cost for fuel and labor.

Assuming that a chimney for a certain plant will cost $10,000, a saving of $8,000, $6,500, or $5,000 can be depended on, according to the type of apparatus installed, the interest on which amounts will go far toward operating the fan. In an installation made by this house, the power used to drive the fan was six-tenths of one per cent. of the total horse power developed, which was 8,000. The fuel burned cost $2.90 per ton.

Buffalo Mechanical Draft Apparatus

Duplicate Induced Draft Fans

Duplicate Fans with Cylinder below Shaft Engines

Arguments in Favor—Continued

Estimating the fuel cost per horse power per hour for one year, we find it to be two per cent. of the estimated cost for the chimney originally planned. That is, it would not pay to build the chimney as long as money was worth two per cent. per annum. This does not consider the fact that a much cheaper fuel can be burned than it is possible to use with natural draft, and this with a very small decrease in heating effect, while the coal bill will be reduced fully one-quarter in most localities, nor does it include the increased efficiency of mechanical draft over chimney or natural draft. Records kept of a number of Buffalo Forced Draft plants show a saving of 30 per cent. in the cost of fuel and at the same time an increase of from 10 to 15 per cent. in evaporative efficiency per pound of coal burned.

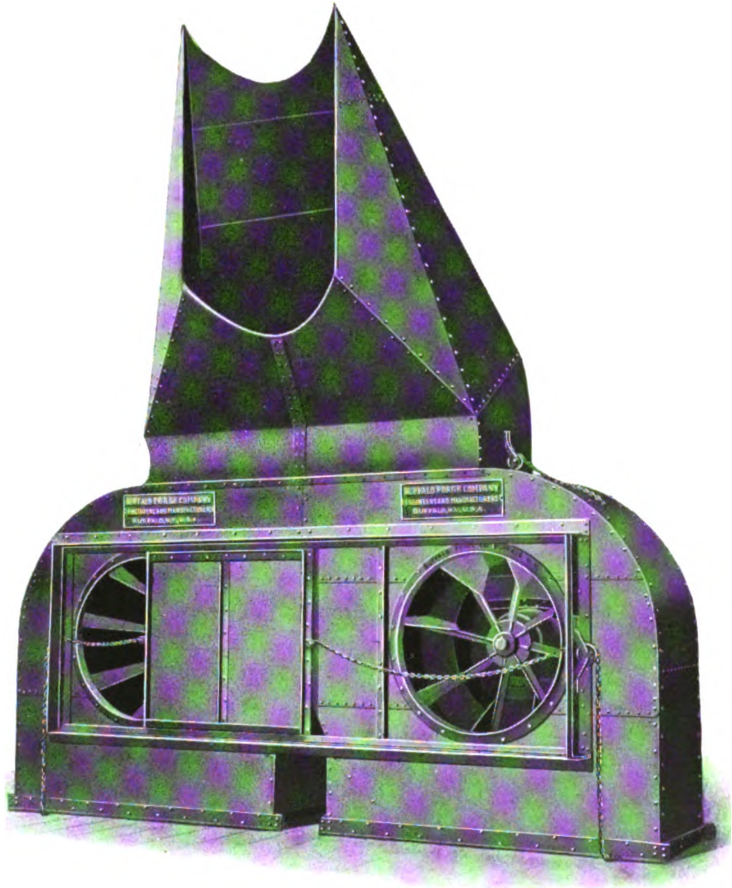
These savings with mechanical draft are especially large when the boilers are run on a varying load, or in case of uneven firing. With chimney draft, the dampers can control only the volume of air passing through the grates, the intensity remaining unchanged, thus resulting in a waste of fuel; while, on the other hand, any variation in the speed of the fan necessarily alters the force of the draft, as well as the volume of air supplied. Again, since the intensity of natural draft depends on the temperature of the flue gases, it is least when the fire burns low, *i. e.*, when it should be greatest. With mechanical draft, by means of a regulating valve, the speed of the fan and the draft intensity increases as the boiler pressure falls and decreases when the steam pressure raises, thus producing the required variation of draft to maintain a practically constant boiler pressure.

The intensity of draft necessary to burn hard coal screenings, culm and such cheap fuels can hardly be obtained by natural draft, while the saving in their use is shown by the table given below in which Barrus compares the efficiency of various mixtures, with Cumberland coal as a standard.

Kind of Coal.	Water evaporated from and at 212° by one lb. of dry coal.	Relative efficiency in per cent. Cumberland = 100%.	Cost of Coal per ton.	Fuel cost of evaporating 1,000 lbs. of water from and at 212°.	Relative efficiency in per cent. measured by cost to evaporate 1,000 lbs. Cumberland = 100.
Cumberland	11.04	100	$3.75	$0.1698	100
Anthracite, Broken	9.79	89	4.50	0.2297	74
Anthracite, Chestnut	9.40	85	5.00	0.2260	64
Two parts Pea and Dust, one part Cumberland	9.38	85	2.58	0.1375	123
Two parts Pea and Dust, one part Culm	9.01	82	2.58	0.1432	119
Anthracite, Pea	8.86	80	4.00	0.2259	75
Nova Scotia Culm	8.42	76	2.00	0.1187	156

Buffalo Mechanical Draft Apparatus

Duplicate Induced Draft Fans



Duplicate Fans arranged for connection to Economizer and Stack

Buffalo Mechanical Draft Apparatus

Arguments in Favor—Continued

WHY GREATER EFFICIENCY.—The subject of operating cost could not well have been treated without entering on the question of improved efficiency, but the reasons for the latter have been reserved for this paragraph. Leaving aside for a moment the technical study of the process of combustion, because the chemical action of combustion by which the carbon of the fuel is converted into carbonic acid gas is generally understood, it will be seen that there is a considerable gain from the fact that the fan, by its automatic regulation, furnishes draft in the amount and at the time needed, thus preventing waste of coal.

To effect this change from 10 to 12 pounds of air per pound of fuel is required, according to the grade of coal used. An excess over the requirements is, of course, necessary to insure the thorough oxidation of all the carbon, but this excess need never exceed 50 per cent. With the chimney draft, however, the amount of air often runs up to from 24 to 36 pounds and sometimes even more per pound of coal. This results in a lower temperature over the grates, and a consequent slow combustion, which is the condition of least efficiency. To secure a higher combustion rate and consequent increase in efficiency, thicker fires must be used and a more intense draft, but these conditions can be attained with chimney draft only by a disproportionately large increase in the height of the chimney and its consequent cost. With chimney draft a consumption of twenty-five pounds of coal per square foot of grate surface is seldom reached. With the fan, however, a consumption of 40 pounds per square foot of grate surface is quite common; this figure is almost doubled in marine service where high pressures are employed, and these results are obtained without any large increase in cost of apparatus. By thus increasing the steaming capacity of the plant, the number of boilers may be decreased in the inverse ratio and the initial cost correspondingly decreased.

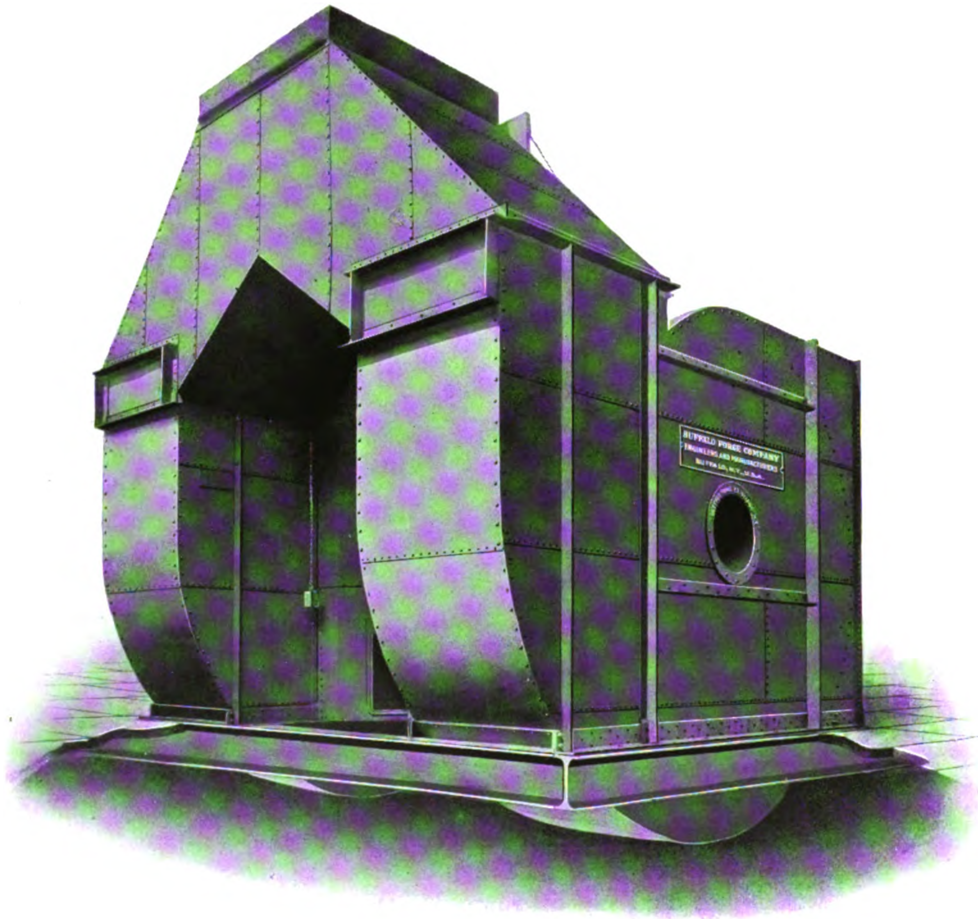
Since in order to secure good chimney draft the flue gases must be at a high temperature, owners are debarred from securing the best results from economizers. Reports of various scientists show that from one-sixth to one-third of the total heat of combustion is wasted in the escaping gases where no economizer is used. Cooling of the gases and resistance offered to their flow by the economizer are no obstacles to the fan, and the losses may, by the combination of mechanical draft and economizers, be reduced to five per cent.

The actual fuel loss in the form of unconsumed carbon in the smoke is very small, usually not over one per cent., but the restrictions of city ordinances often make natural draft out of the question on this account. With careless handling, no form of draft will prevent this nuisance, but the supply of a proper amount of air under an intense draft will, in conjunction with good firing, operate to prevent smoke production.

The use of mechanical stokers has done much to improve evenness of firing, but the best results cannot be obtained from them without mechanical draft, and the modern forms of underfeed stokers and hollow blast grates are expressly designed to operate in connection with forced draft.

Buffalo Mechanical Draft Apparatus

Duplicate Induced Draft Fans



Duplicate Fans arranged for Connection to Economizer and Stack

Arguments in Favor—Continued

CONVENIENCE.—Under this head might properly come many points mentioned elsewhere, but there are others more purely ethical, such as the avoidance of wear and tear on the temper on mornings when the draft is sluggish, and the boilers refuse to steam. Atmospheric conditions which may render a chimney useless have absolutely no effect on fan draft. The quality of fuels may vary and require a different intensity of draft.

The chimney once built, besides taking up much valuable space, is fixed in its location for life. Mechanical draft may be easily arranged so that the apparatus occupies no floor space, and if it is found advisable to remove or change the position of the boilers, no part of the power plant is more easily transported than the fan.

LIABILITY TO DAMAGE.—To obtain the greatest advantages of Mechanical Draft, the fan or fans should be provided with direct-connected engines on account of the perfect control and regulation thus obtainable, and their entire independence of any outside source of power. Thus the fan may be started before the main engine in the morning and in a very short time get the fires in the right condition to carry the load. It has been argued that there is a greater liability to loss with the use of fans by stoppage in draft from a breakdown in the fan or engine, but an examination of records will disprove this. The construction throughout is of the best and simplest, and the factor of safety employed is many times greater than in most of the machinery equipment of the shops. When the duplex induced draft system is installed, there is no possible shut-down of the plant, since either fan alone is sufficient. Many installations made by this house have been in constant operation for over twelve years, without having cost a penny for repairs.

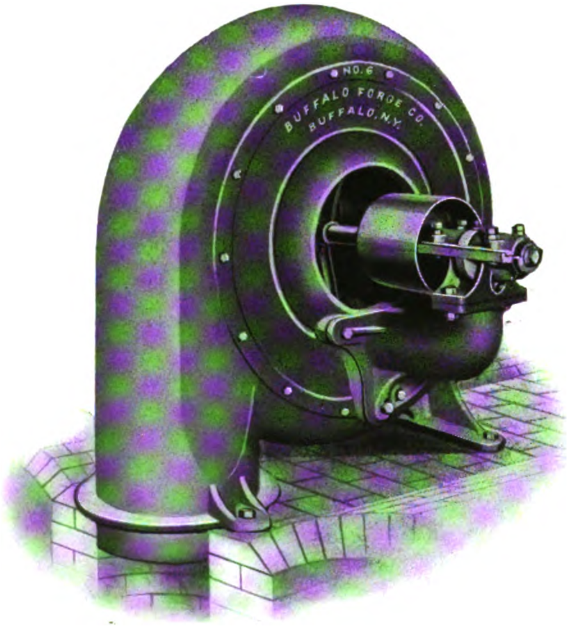
The possibility of loss is often greater with chimney draft than with mechanical draft. During the years 1900 and 1901 especially, the windstorms in various parts of the country played havoc with the stacks, which were laid low, causing much damage to adjoining buildings as well as their own total loss. In many cases these were replaced by the fan with its short stack, and hardly a day passed that we did not receive inquiries from such unfortunate manufacturers or others who dreaded the results of such a catastrophe.

VARIOUS APPLICATIONS.—With forced draft, sometimes known as the plenum system, the application of air is beneath the grates through a damper in the ash-pit, by which an additional means of regulation is supplied, making each boiler independent of the remainder of the battery. Preferably, the damper is embedded in the bridge wall as shown in the cuts on page 64, the air is directed downward and distributed evenly beneath the grates. In a new plant the bridge wall may be built hollow, with dampers opening directly out of it; when forced draft is applied to existing plants, tile or brick ducts convey the air to the dampers, which are placed in the same position as before. Both of these arrangements are illustrated on page 64.

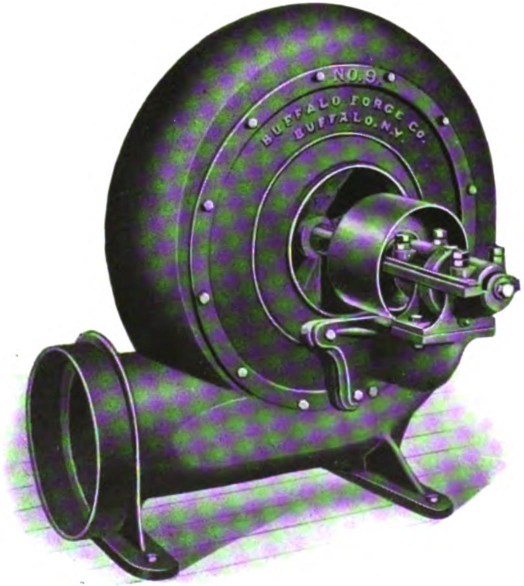
The fan may be set above the boilers connecting by means of a sheet metal duct, or on the floor, in which case it is often of the three-quarter housing type discharging directly into the underground duct.

Buffalo Mechanical Draft Apparatus

Buffalo "B" Volume Blowers



Right-hand Bottom Vertical Discharge, showing usual position on Boiler Settings



Right-hand Bottom Horizontal Discharge, used for small Forced Draft Plants

Buffalo Mechanical Draft Apparatus

Arguments in Favor—Continued

Buffalo "B" Volume Blowers, having cast-iron shells, and designed for the heaviest service, delivering air at pressures up to six ounces, were first employed for forced draft, and are installed in small plants or where fuel requires high air pressure to insure complete combustion. Various forms of underfeed mechanical stokers, and special grates, mostly of the hollow blast type, are designed to operate in connection with forced draft under heavy pressures. The Buffalo "B" Volume Blowers have been adopted by manufacturers and users of such devices for their durability and efficiency.

When induced draft is used, the smoke connection from the boilers is brought directly to the inlet of the fan, which usually discharges upward through the short stack, the weight of which it supports. When two fans are used, the connections are made so that by operating a damper, the gases may be passed through either fan. The location and type of apparatus is determined in all cases by convenience.

Advantages of Induced Draft.—Generally speaking, a comparison of results attainable with the plenum and vacuum systems shows an advantage for the latter, but this cannot be laid down as a rule, since each method has its advantages under certain conditions which may be sufficient to cause its adoption. When mechanical draft is used to help out an overloaded or insufficient chimney, the blower is of the greatest assistance.

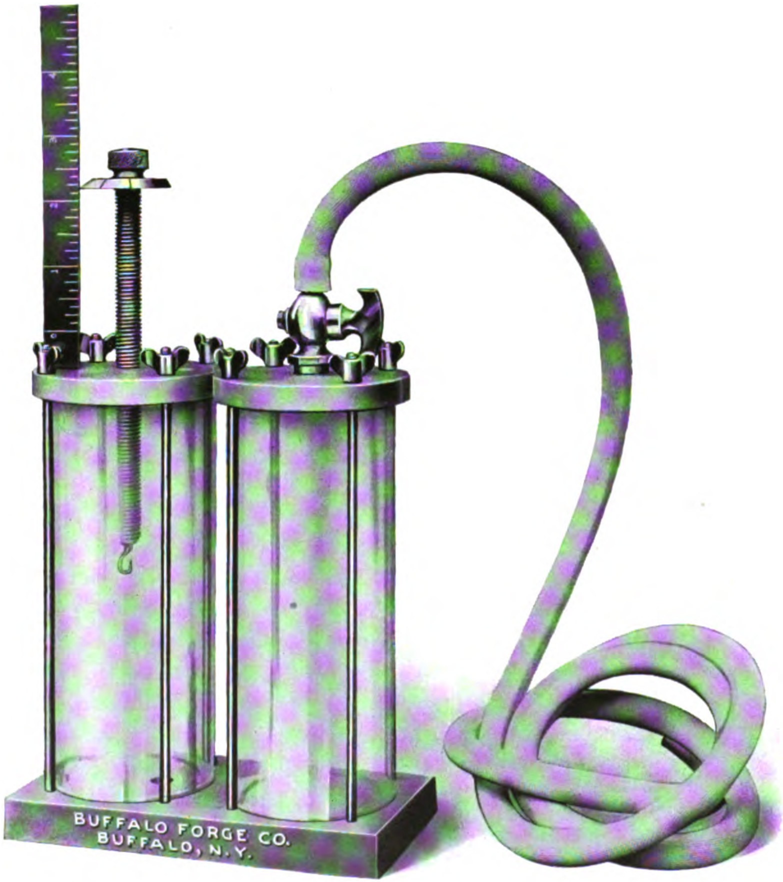
In burning the lowest grades of fuel, such as hard coal screenings or culm, forced draft is especially desirable. The pioneer outfits for burning culm were designed by this house, and hundreds of the original plants are still in operation and giving the best results. As mentioned before, this system is also applied with most forms of stokers and hollow blast grates for which it is especially adapted.

We have shown in the comparison of first costs that induced draft is slightly more expensive than forced, on account of the larger apparatus required for the same boiler horse power. The ratio is not fixed, since the air capacity required of an induced draft fan varies with the absolute temperature of the gases. Roughly it is twice that of the fan for forced draft. Since, however, the density of the gases varies in the inverse ratio of the absolute temperatures, the power required to move them is little greater than with forced draft.

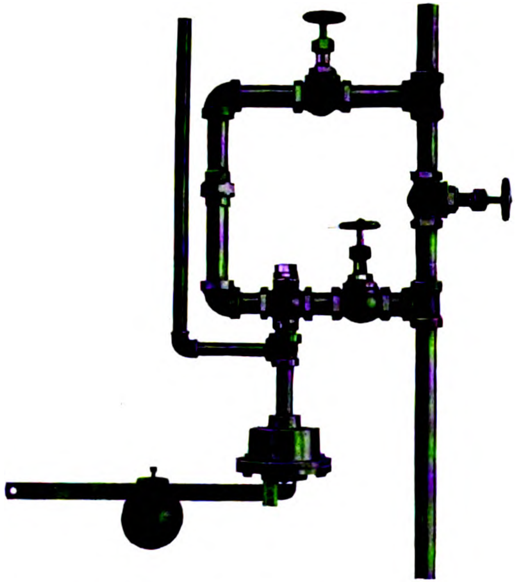
Induced draft affords the greatest benefits of economizers, as the system is especially adapted to this end. Other features in favor of the system are in the line of convenience and saving of labor in operation and installation. No changes are necessary in boiler settings, such as introducing dampers or air ducts. The draft being more uniformly distributed over the grates, the fires require less attention to make them burn evenly. There is less deposit of soot in the boiler tubes, on account of the higher velocity of the gases passing through. This makes frequent cleaning unnecessary. Free access may be had to the ash-pit or to the fire-box without blowing out into the room, since pressure is inward rather than outward. For the same reason, there is no deposit of dust and fine ash in the boiler room which may occur with forced draft if the boilers are not air-tight.

Buffalo Mechanical Draft Apparatus

Hook Draft Gauge and Fan Engine Speed Regulating Valve



Buffalo Improved Hook Draft Gauge



Correct Method of Connecting a Fan Engine Speed Regulating Valve

Buffalo Mechanical Draft Apparatus

Hook Draft Gauge and Fan Engine Speed Regulating Valve

Buffalo Hook Draft Gauge, being constructed entirely of aluminum, brass and glass, will resist corrosion much better than draft gauges usually placed upon the market. It consists essentially of two glass cylinders, one being air tight and connecting by means of a rubber tube to the chamber in which the draft is to be measured. This cylinder communicates through the base with the second cylinder. In the second cylinder is placed a calibrated screw. On the end of this screw is a hook for piercing the surface of the water. When using the instrument it is essential that it remain in a fixed position. It is not necessary to know the quantity of water in these cylinders. The water column is measured as follows:

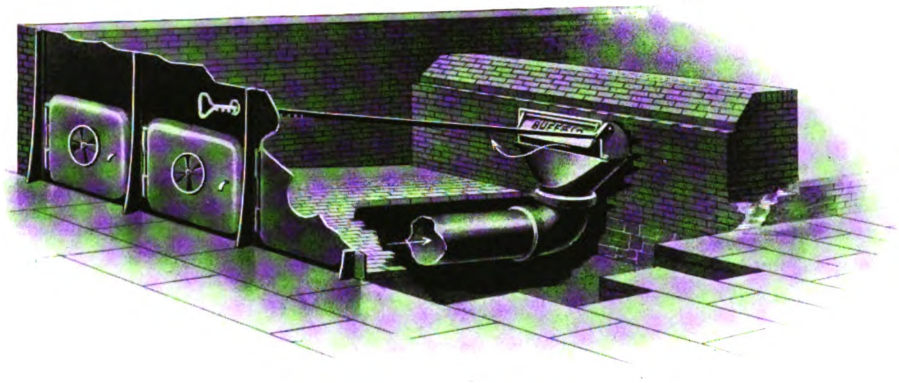
First, lower the hook under the surface of the water; then by means of the screw raise the hook until it touches its reflection on the surface of the water. Then make connection with flue by means of the rubber tube. The column of water will lower in the first cylinder and raise in the second. After the water has reached a balance, again raise the screw until it touches its reflection on the surface of the water as before. The distance through which you raise the screw will be shown on the scale and is one-half the height of a water column corresponding to the pressure of the air.

The illustration on opposite page shows the proper method of connecting a fan engine speed regulating valve. The upper pipes should always be run direct to the boiler. Under no circumstances can the small piping to the left be taken from another pipe which is supplying steam to a different point. The larger pipe can be taken off from main steam supply, but this will tend to impair the efficiency of the system and make it much less sensitive than when this pipe communicates direct to the boiler. The lower right-hand pipe leads direct to the fan engine, but the valve should not be placed too close to the engine. The volume of steam in this pipe between the valve and the cylinder of the engine should be double the volume of steam contained in the cylinder at cut-off. The failure to realize the importance of this steam volume leads to very bad results. The valve should be hung plumb and level with the side marked "Inlet," placed to the left when piping stands as shown by the illustration. After the valve is placed in position, see that it does not bind in the post. The cap can be removed for examining the valve. By moving the weight to the left, the fan will maintain a higher steam pressure in the boiler by working in the following manner:

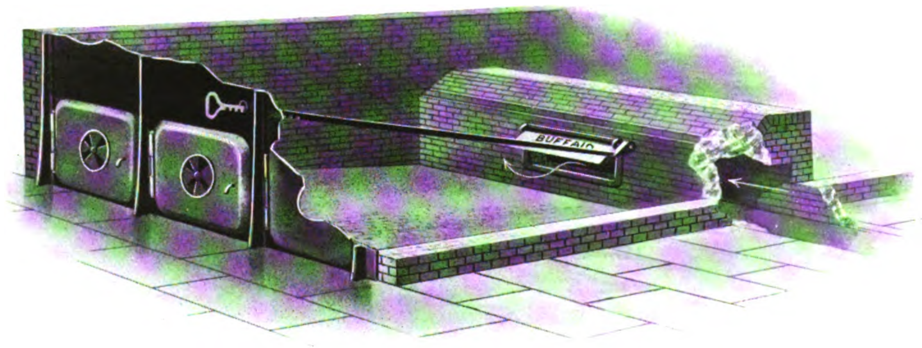
The weight tends to keep the valve open at all times. The steam pressure of the boiler counteracts this action by pressing against a diaphragm in the valve. When the valve is set for a steam pressure of 100 pounds, the pressure on this diaphragm will be sufficient to raise the weight and close the valve, thus shutting off the engine. When the steam pressure in the boiler falls, the pressure on the diaphragm is much less and the weight falls, thus opening the valve and starting the engine, producing a strong draft which will soon cause the pressure in the boiler to raise until it again reaches the required point.

Buffalo Mechanical Draft Apparatus

Forced Draft Regulating Dampers



Method of Applying Buffalo Dampers to Underground Tile



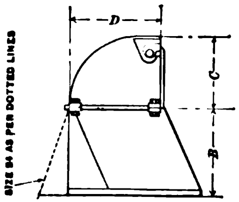
Method of Applying Dampers to Hollow Bridge Wall

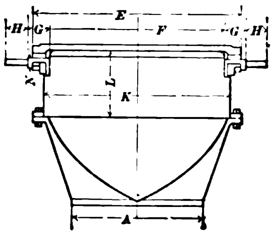
Buffalo Mechanical Draft Apparatus

Buffalo Draft Regulating Dampers

Buffalo Draft Regulating Dampers are illustrated in two styles. The type selected in each instance depends upon the mode of conveying the air from the fan to the ash-pit. The two methods most usually employed are well illustrated on the opposite page. The first illustration shows a damper designed to communicate with a system of underground tile piping leading from the fan to the boiler. The second shows the damper usually employed when the air duct is built in the bridge wall. Either damper is guaranteed to give entire satisfaction. Where it is inconvenient to introduce the air currents through the bridge wall, a damper with a special arrangement of levers is employed. The regulation of the draft is so excellent and so perfectly under the control that many consider it sufficiently adequate for practical economy without the addition of more expensive arrangements, whereby the speed of the fan and engine would be controlled according to the boiler pressure. Whether such automatic regulation be installed or not, these regulating dampers are very important and cannot be easily dispensed with. The damper employed with the hollow bridge wall can readily be supplied with any given dimensions. Dimensions of the dampers for underground tile are not so readily changed, and it is essential that the dimensions and sizes given below are strictly adhered to when designing a system to employ underground tile piping.

Detail drawings showing the best location for the fan air ducts and draft regulating dampers will be furnished, to prospective purchasers, upon application.



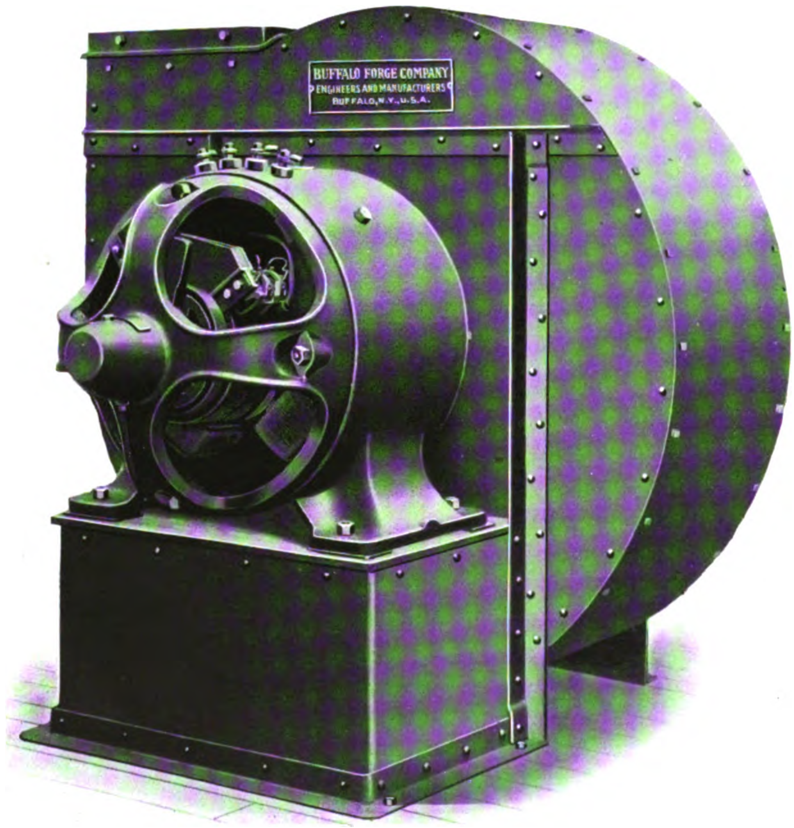


Dimensions of Draft Dampers for Tile Duct.

Size.	A	B	C	D	E	F	G	H	K	L	N
12 in.	12¼	8	7	8½	19½	16½	1⅞	2	17½	6½	1
14 "	14¼	8	8½	9½	22½	19½	1⅞	2	20½	8	1
16 "	16¼	8	10	10½	25½	22½	1⅞	2	23½	9½	1
18 "	18¼	8	10	10½	30⅞	27½	1⅞	2	28½	9½	1
24 "	24¾	8	12¾	15½	39¼	35¼	1⅞	2	37	12	1

Buffalo Mechanical Draft Apparatus

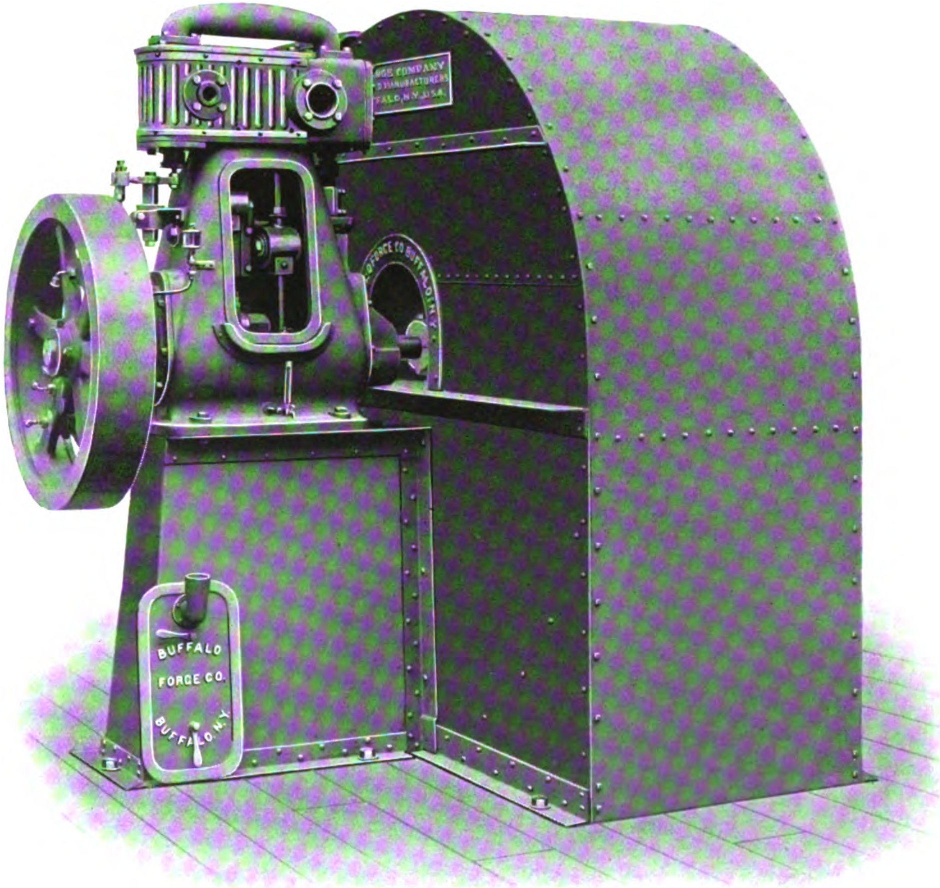
Buffalo Special Steel Plate Fan



Right-hand Full Housing Up Blast Discharge Fan with Motor.

Buffalo Mechanical Draft Apparatus

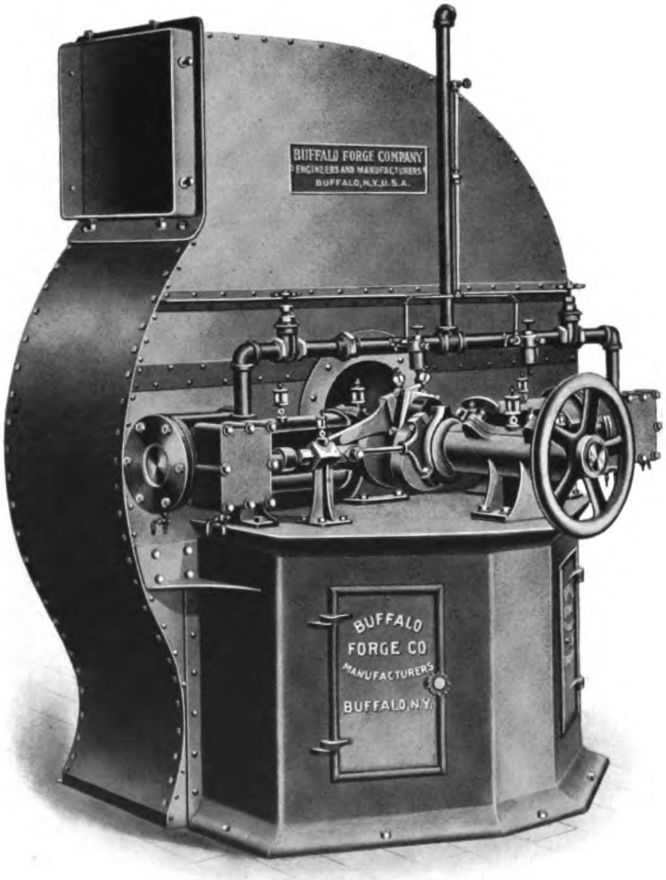
Buffalo Special Steel Plate Fan



Left-hand Full Housing Down Blast Discharge Fan with Cross Compound Engine.

Buffalo Mechanical Draft Apparatus

Buffalo Special Steel Plate Fan



Full Housing Steel Plate Fan with Double Horizontal Engine.

Buffalo Mechanical Draft Apparatus

Buffalo Special Steel Plate Steam Fans

Buffalo Special Steel Plate Fans are used to accomplish results of an unusual nature, and therefore the design and construction vary with each particular machine. For this reason they are always built to order. No standard list of these fans can be given which would cover all requirements. This house makes fans varying greatly with respect to size and style and in each case they are so proportioned as to especially adapt them to the work which it is desired to perform. A type and size of engine having ample power is selected and one which is well qualified to withstand all that is required of it under the existing conditions.

For high pressure and great velocities of air it would be necessary to run steam fans, as ordinarily built, at so high a rate of speed that the life of the engine would be of short duration. Where these conditions exist Buffalo Special Steel Plate Fans are built with narrow wheels, the diameter being much greater than the usual practice. This results in a correspondingly increased pressure of air secured by giving to the wheel a larger peripheral velocity and delivering the air through a comparatively small outlet.

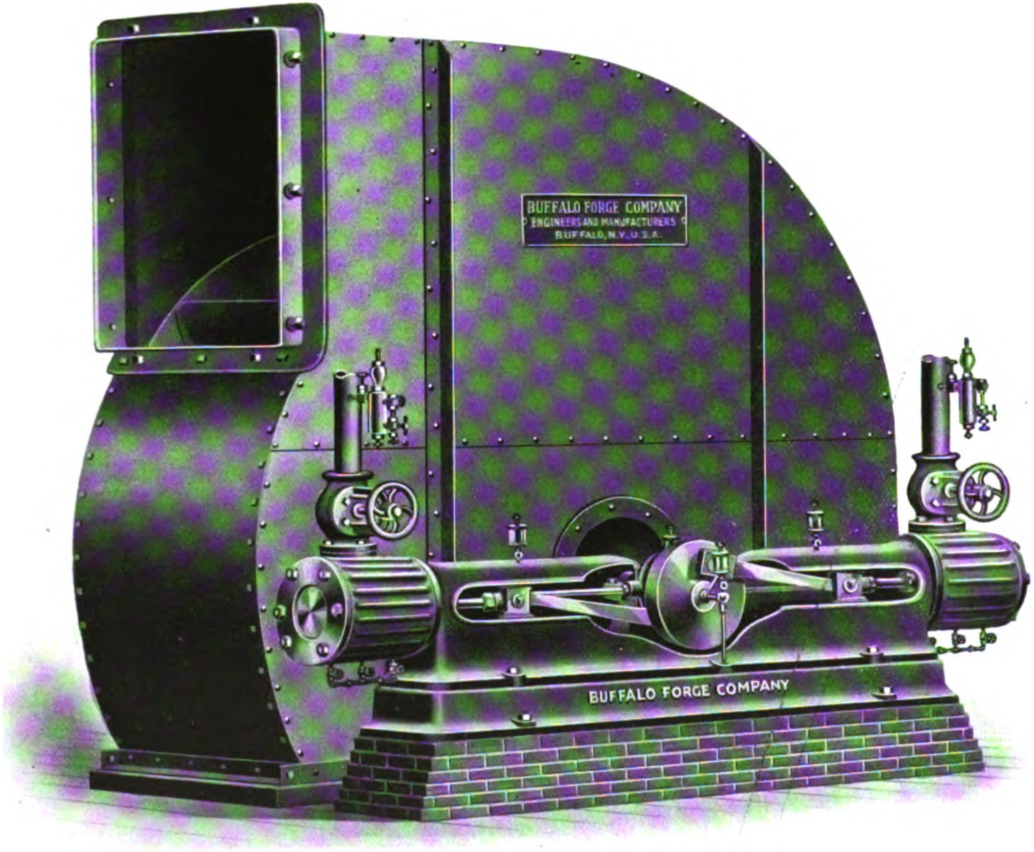
Several Special Buffalo Steam Fans are illustrated by the accompanying cuts. The one appearing on the opposite page was built for United States ships. The work required of the fan was to produce forced draft under the boilers, and also to ventilate different portions of the vessel. The condition of the installation which are common for similar work necessitated strong, substantial construction, and the best grade of engine for high speed under continuous use. The arrangement and design of the engines are such that each has ample capacity to drive the fan independently. Both engines may be operated simultaneously, if desired, or the fan may be driven by either alone, thus always having one engine in reserve.

The engraving appearing on page 67 is a good illustration of the Buffalo Steel Plate Steam Fan. This fan has a cross-compound vertical engine with the cylinders above the shaft. The bearings are water-cooled and the engine is entirely inclosed and runs in oil. These measures insure a perfectly smooth and easy-running fan with absolutely no danger from overheated bearings. Generally speaking, however, for marine and the other duty requiring continuous operation the double type of engine is to be preferred to the single unless there is an equipment of duplicate plants. In an installation of the latter type a single engine, properly designed and constructed, will render efficient service and require only ordinary attention.

Since the practice of applying Buffalo Steel Plate Steam Fans for forced draft, and ventilation has proven so eminently successful in the great ocean vessels, they are now not only being universally employed for all large boats, but are adopted in smaller ones as well. Small steamships can be ventilated and supplied with the forced draft system for their boiler fires as readily and with results equal to those of larger ones. For continuous running and especially for high speed, the double upright inclosed engine direct-connected to the Buffalo Steel Plate Fan embodies the acme of efficiency and durability.

Buffalo Mechanical Draft Apparatus

Buffalo Special Steel Plate Fan



Three-quarter Housing Steel Plate Fan with Double Horizontal Engine.

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Buffalo Double Horizontal Engines

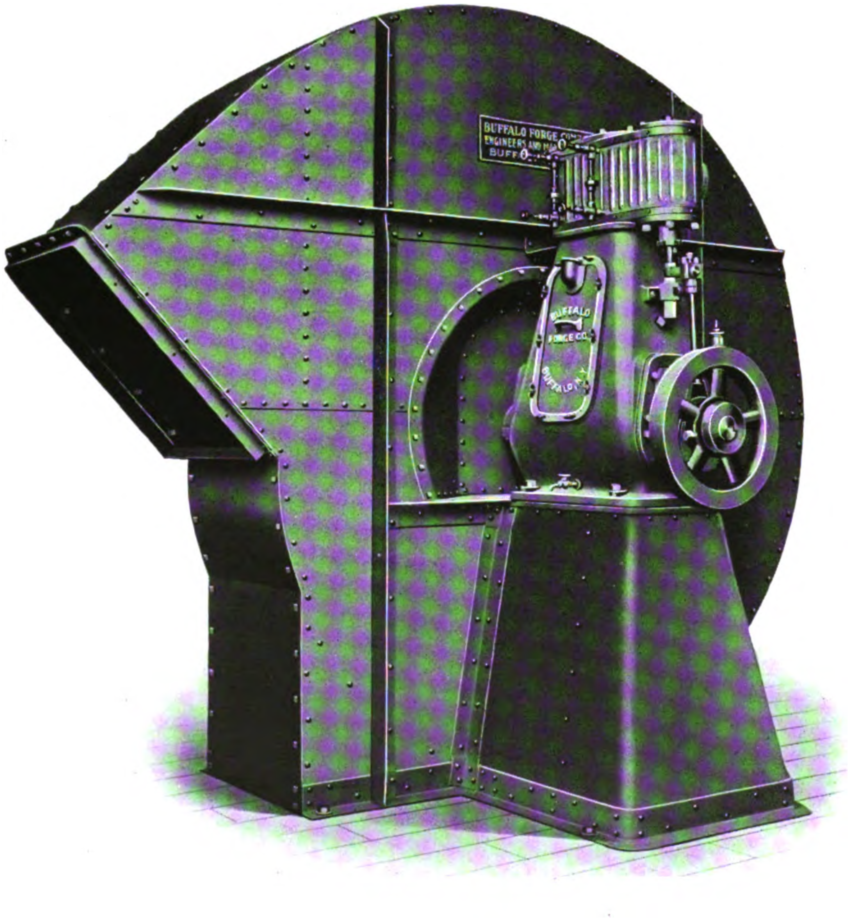
Special Double Horizontal Engine Fans herewith illustrated and described were originally designed especially for use on vessels of the United States Navy. High speeds, high boiler pressures and continuous operation, incident to the navy requirements, call for unusually strong, substantial fans with engines of the highest grade of construction. Space is too limited to show and describe all of the designs of special fans with horizontal engines which have been built by this house for various requirements. Photographs of other types will be supplied upon request of prospective purchasers.

The engraving on the opposite page shows a fan with double horizontal engines, one being placed on either side of the crank shaft, which is extended into the fan and forms a direct-attached machine by reason of the fan wheel being placed on the opposite end of the shaft. But one of the engines is intended for use at a time, the other rod being disconnected and held in reserve in case of an accident, although the design is such that both may be operated simultaneously, if desired. In the construction of this engine, the desirable point of being able to quickly change from the right to the left-hand engine, or the reverse, at the same time keeping a perfect balance, has been embodied. This feature is accomplished in the following manner: The disc is made sufficiently heavy on the side on which the pin is placed to counterbalance the crank and connections when the left-hand engine connected to the crank is in use. Then when the left-hand engine is disconnected and the right-hand engine is connected up, the pocket provided in the disc on the opposite side from the pin is filled with shot and the balance re-established for the right-hand engine when the left-hand engine is held in reserve. The pocket in which the shot is placed is stopped with a threaded plug inserted with a screw-driver and makes a neat finish. It may be filled or emptied in a few seconds time. The crank shaft is of forged steel, of ample proportions, which is a distinguishing feature of Buffalo Steam Fans. Sufficient space is left between the crank and the disc for the eccentric and a bearing of ample wearing proportions. The valves employed are of the piston type, carefully fitted up with cages and snap ring packing. They are attached to the valve stem by a simple, efficient method, which permits of the removal of the valve with the greatest ease. Other general construction details are similar to those found in the Buffalo Center-crank Engines.

The illustration shows a large fan in three-quarter steel plate housing, the lower portion of the scroll being brick-work, and is used for blowing a battery of stationary boiler fires. On shipboard, full housing fans are employed, and where a double horizontal engine is desired, a cast-iron supporting base may be furnished, or the lower scroll of fan extend below the floor line. The advantages of double horizontal and upright engines, so designed that each has ample capacity to drive the fan at its maximum speed, with the provision in both types of either engine being used separately or simultaneously are obvious. The cylinders are of large diameter compared with the stroke, with the result of developing large powers at high rotative but moderate piston speed.

Buffalo Mechanical Draft Apparatus

Special Discharge Fan with Double Double-acting Engine



Right-hand Full Housing Special Discharge Fan with Double Cylinder above Shaft Engine.

Buffalo Mechanical Draft Apparatus

Steel Plate Fan with Double Double-acting Engine

DOUBLE DOUBLE-ACTING ENGINES are used with fans where it is important to economize space. They embody the necessary characteristics of being small and compact in proportion to the power developed. The original installation of an engine of this type was upon an important merchant marine. The fans were not installed in duplicate, two being used because the available space was of such nature that a single fan of sufficient size could not be employed. The arrangement provided the desirable feature that in case either were disabled it would be possible to keep conditions normal during the time necessary for repairs.

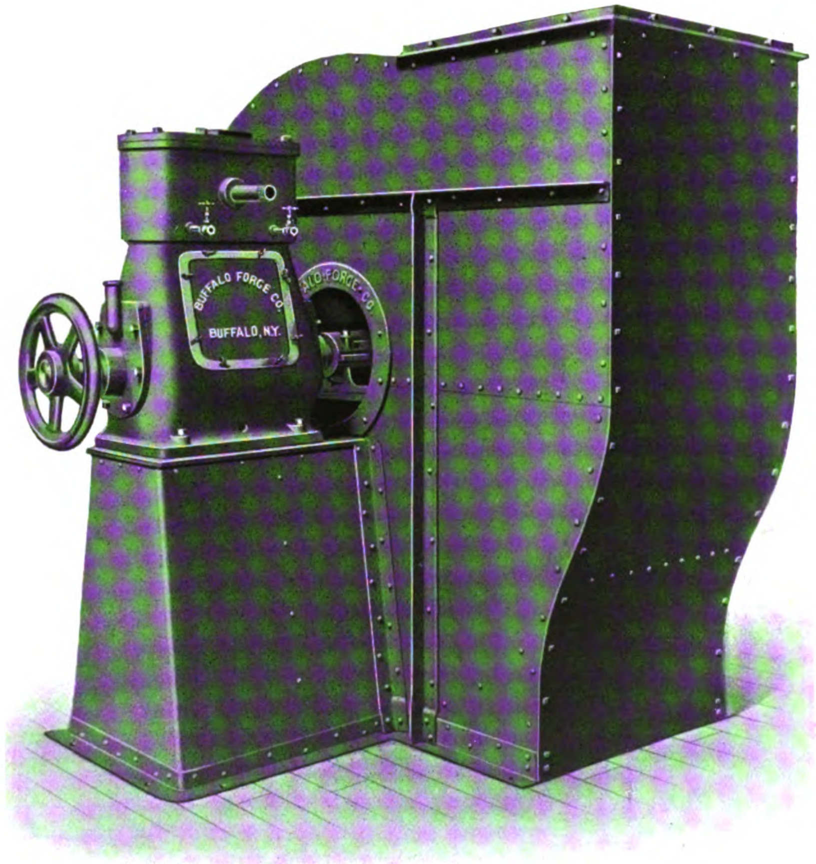
While these engines are double-acting, both cylinders are supplied with steam from one valve. The valve is made of either the piston or slide valve type. The cranks are set at one hundred and eighty degrees apart and both connecting rods and crank shaft are made of forged steel. The connecting rods are made of the marine type at the crank end, and of the wedge type at the crosshead end. The bearings are all babbitted, and where the engine is connected to an induced draft apparatus arrangements are made for water-cooled bearings. A continuous spraying action practically bathes all bearing surfaces in oil, thus reducing frictional losses to a minimum. Where high speed is desirable no other type of engine is so well adapted to the work as the Buffalo Double Vertical Double-acting Engine.

The double upright engine fans are unequaled for mechanical or induced draft in power plants and are employed in the largest outfits in operation in this country, usually in conjunction with fuel economizers. In such service, the fans are usually arranged in pairs and are built with overhung wheels, water-cooling boxes and other departures from the regular form, to prevent the journals from heating and the working parts from destruction by the action of the gases produced in fuel combustion. The fan housing also receives special attention, and is thoroughly braced with heavy angle iron frames, which hold it rigid under all strains. Smoke stacks are frequently placed directly on top of the housing, where fans are employed in connection with fuel economizers and the induced draft systems.

The lubrication of the Buffalo Double Upright Engine is accomplished in a uniform and positive manner, a result obtained only by the method employed in this and other types of uprights manufactured by this house, fully described in our Engine Catalogue. An honest investigation of every detail of this engine can have no other result than an acknowledgment of unequaled construction and design. Prominent features are a heavy frame with width of base that gives greatest stability, accessibility for packing and repairs by mean of the large dust-proof doors, and large surfaces of all parts subject to wear. Hardened pins are employed wherever possible, and a special composition of metals is used for the cylinders and valve, while every wearing part has ready means for adjustment. Simplicity of construction, and highest grade of material and workmanship (upon which depends durability) could not be combined to greater advantage.

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Buffalo Double Single-acting Engines



Left-hand Full Housing Up Blast Discharge Fan with Double Single-acting Engine

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Buffalo Double Single-acting Engines

Buffalo Double Single-acting Engines are especially adapted for direct-connection to small sizes of fans upon small steam yachts and boats of average size. In this capacity they have been widely used, and have always given satisfaction. They are usually arranged to serve the double purpose of ventilating as well as producing mechanical draft for the boilers. The full effectiveness of the boilers is always assured. In marine work it is especially desirable to produce the largest amount of steam with the smallest amount of boiler space. Since the introduction of Buffalo Steel Plate Fans to this work the space required for a given boiler capacity has been very materially reduced. By the proper application of these fans to marine boilers, so marked an increase of speed has been noticed that owners of lines, who have observed the benefits derived from an initial fan, are speedily installing them into all of their ships.

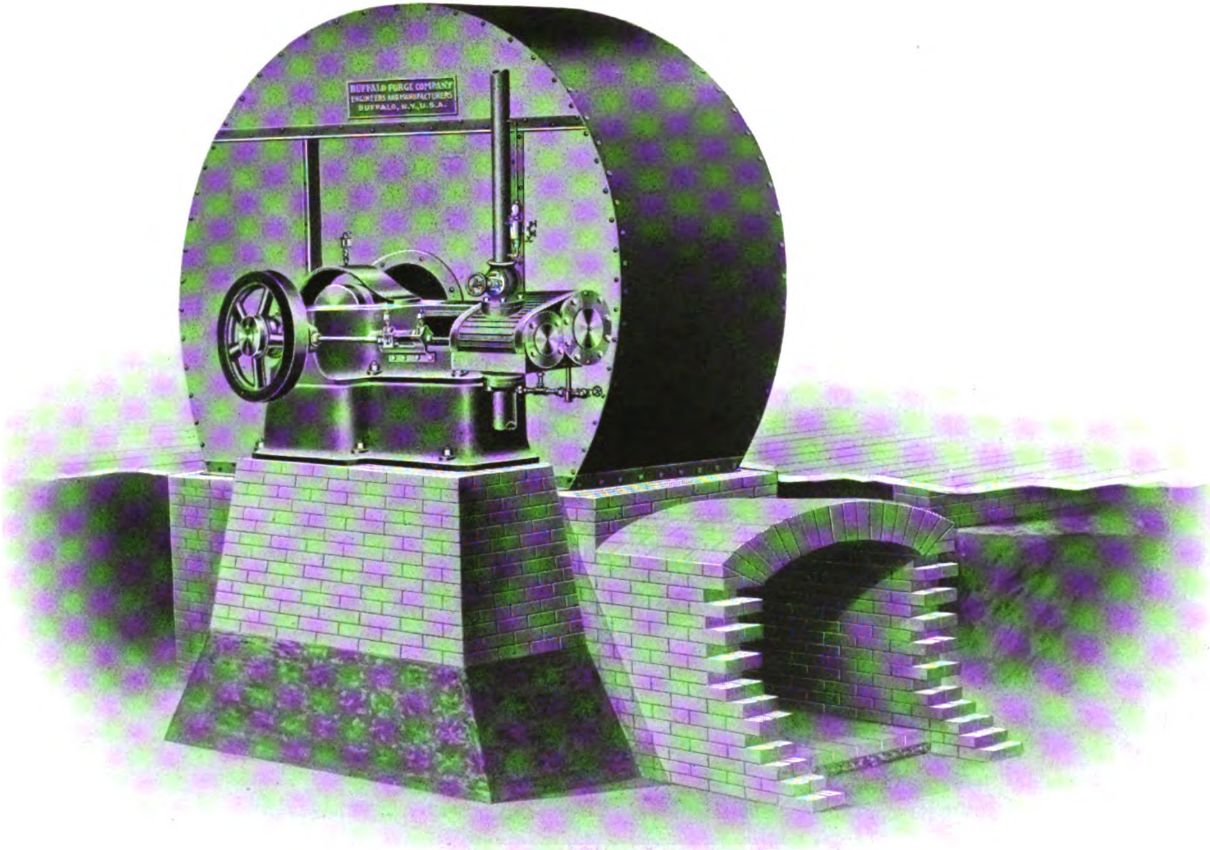
In steamers equipped with fan ventilation, the old form of ventilating pipes, whose efficiency was very low at best and never reliable, especially under unfavorable conditions of the weather, is entirely dispensed with, and the whole dependence is now placed upon the fan. Marked success has accompanied the fan system of ventilation as applied to fruiting steamers. By keeping the fruit in the hold of the ship supplied with pure, fresh air, the decrease in percentage of decay has often been enough, even on a single trip, to pay for the cost of the installation. Forced draft and ventilation are secured with the same fan.

The illustrations on page 74 show to good advantage the simplicity and compactness of design of these direct-connected engines. The engine is entirely inclosed, and the moving parts run in oil. Interior frame pockets constantly filled with oil thoroughly lubricate the main bearings. These engines are made with or without governors as desired, and are built in sizes suitable for fans up to one hundred inches. A close inspection of the illustration will reveal the admirable base provided for the engine. Both cylinders are supplied with steam by the action of the same valve, thus further simplifying the design, and reducing the moving parts to a minimum. The valve is placed between the cylinders and is of the piston type. By means of this arrangement the steam has very little distance to travel through ports.

The advantage this type of engine possesses over all other types is the saving in space. This important result is accomplished by doing away with the piston rod, and thereby reducing the height of the engine at least one-third. The connecting rod is coupled directly on to the piston head, and is of the ordinary type with a marine end. It is made of the best quality of cast steel and amply proportioned to withstand all strains that come within the work for which the engines are designed. Another great advantage of this type of engine is its ability to run at high speeds. This property makes it doubly valuable in places where great economy of space is demanded and at the same time a large air capacity. By running one of these engines direct-connected to a medium-sized fan the desired result may be easily obtained in spite of the adverse conditions.

Buffalo Mechanical Draft Apparatus

Steel Plate Fan with Buffalo Center-crank Engine



Left-hand Three-quarter Housing Bottom Horizontal Discharge Fan Direct-connected to Buffalo Engine.

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Buffalo Center-crank Engines

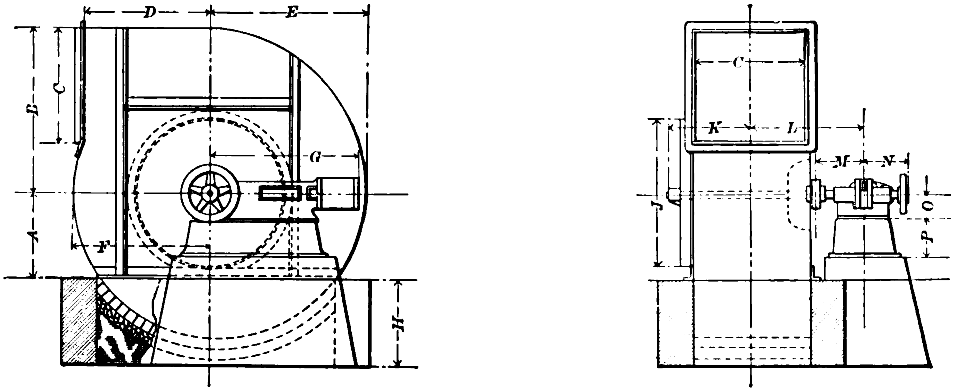
Buffalo Center-crank Engines are often direct-connected to three-quarter housing fans or belted to the larger sizes of full-housing pulley fans. The foremost aim in producing this design of engine was to secure a type which would develop a large amount of power at high rotation but modern piston speed. With the possibility of entirely inclosed working parts, the engine is thus particularly fitted for most efficient service in the numerous trying situations. While some of the engine features are unusual, no deviation is made from established laws in proportion and design for the sake of novelty. Each detail is wrought with fitness to perform its particular function, so that when assembled the result is a compact and symmetrical machine.

As clearly shown by the engravings, the engine may be built wholly or partially inclosed, as desired. The oiling devices are positive and may be supplied in the several forms illustrated, or a common oiling chamber with oil flowing over the reciprocating parts may be used. The engine frame is rectangular, wider at the base than at the bearings. In the smaller sizes, the cylinders are integral with the base, and are so arranged that the piston can be readily removed by withdrawing the bolts of the cylinder head and lower end of connecting rod, whereby the crosshead, cylinder head and piston can be lifted out without removing any other part. The steam chest may be easily examined when desired. The crosshead slides are so fitted with shoes as to enable adjustment for wear. They have special babbitt metal gibs to prevent cutting of slides, and clamp joints for the piston rods, which are bored tapered to receive the hardest wrist pin. The pistons are of the snap ring pattern, the rings of which are of special metal (permitting use for a long time without lubrication). The valve is of the piston type, steam being admitted at center instead of at the ends. The rods have large wearing surfaces, the crank end is lined with babbitt, and the crosshead end has phosphor bronze boxes with wedge adjustment. The crank end adjustment is similar to that of the marine type; the shaft is of forged steel, the cranks being opposite each other. The eccentric strap is lined with genuine babbitt, the bearings, which in their ratio are large, are bolted to the main housing, and lined with a special brand of babbitt metal, also fitted with our improved sight feed lubricator.

While every portion is made as compact as possible, yet the arrangement gives ready access to all parts of the engine without disturbing others. The stuffing boxes are provided with nuts which screw on to the glands, and while standard packing is employed, if so ordered and desired, approved metallic packing may be substituted. To prevent corrosion, brass glands are used; the valve rod is of steel, and fitted with hardened pin and clamp joint. The steam chest head has a phosphor bronze bushing to form a guide for the valve rod. The eccentric rod has means for adjusting valve without removing cover. No rocker or its substitute is used, the object being to reduce the engine details to the fewest possible number—a great desideratum in all engines. A hand wheel on the shaft, that the engine may be thrown off the center, is provided.

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Buffalo Center-crank Engines



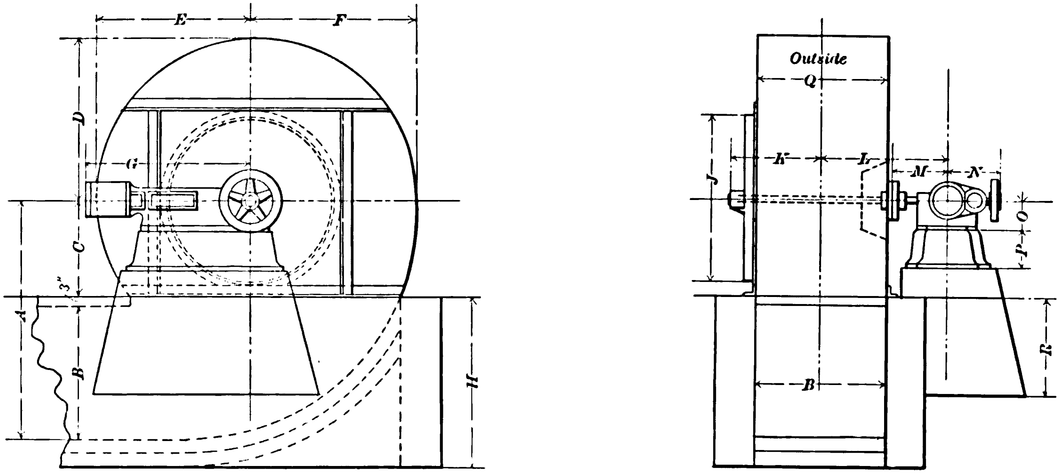
THREE-QUARTER HOUSING RIGHT-HAND TOP HORIZONTAL FANS, DIRECT-CONNECTED TO BUFFALO HORIZONTAL CENTER-CRANK ENGINES.

Size of Engine, Inches.	Size of Fan, Inches.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
5 x 6	100	27½	51⅝	37¼	40 5/16	48⅞	43⅜		30	46¼	25½					
6 x 6	110	30¼	56¾	41	44⅜	53¾	47¾		30	51¾	28					
6 x 8	120	31⅞	61⅞	44¾	48 7/16	58⅝	52⅛	50⅝	36	55	30⅛	41	15¼	17¼	9	12¾
7 x 8	130	35½	67	48½	52½	63½	56½	50⅝	36	60¾	33	43	15¼	17¼	9	12¾
8 x 8	140	38	72⅛	52¼	56 9/16	68⅜	60⅞	50⅝	36	64¾	35⅛	45	15¼	17¼	9	12¾
8 x 10	150	40¼	77¼	56	60⅝	73¼	65¼	65	42	69½	37½	52	20¼	21½	12½	16¼
8 x 10	160	42⅝	82⅜	59¾	64 11/16	78⅛	69⅝	65	42	74	41¼	53	20¼	21½	12½	16¼
9 x 10	170	46	87½	63½	68¾	83	74	65	42	79¼	43	55	20¼	21½	12½	16¼
10 x 10	180	48½	92⅝	67¼	72 13/16	87⅞	78⅜	65	48	84	45¾	57	20¼	21½	12½	16¼
10 x 12	190	51	97¾	71	76⅞	92¾	82¾	82	48	88½	47¾	64	22⅝	24	14⅞	20
11 x 12	200	53½	102⅞	74¾	80 15/16	87⅜	87⅛	82	51	92½	49⅝	66	22⅝	24	14⅞	20

Dimension "J" refers to exhausters only. Blowers have two inlets each with a diameter equal "J" in the next lower size exhauster. Tables of capacities, pages 114 and 115. All dimensions are in inches.

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Buffalo Center-crank Engines



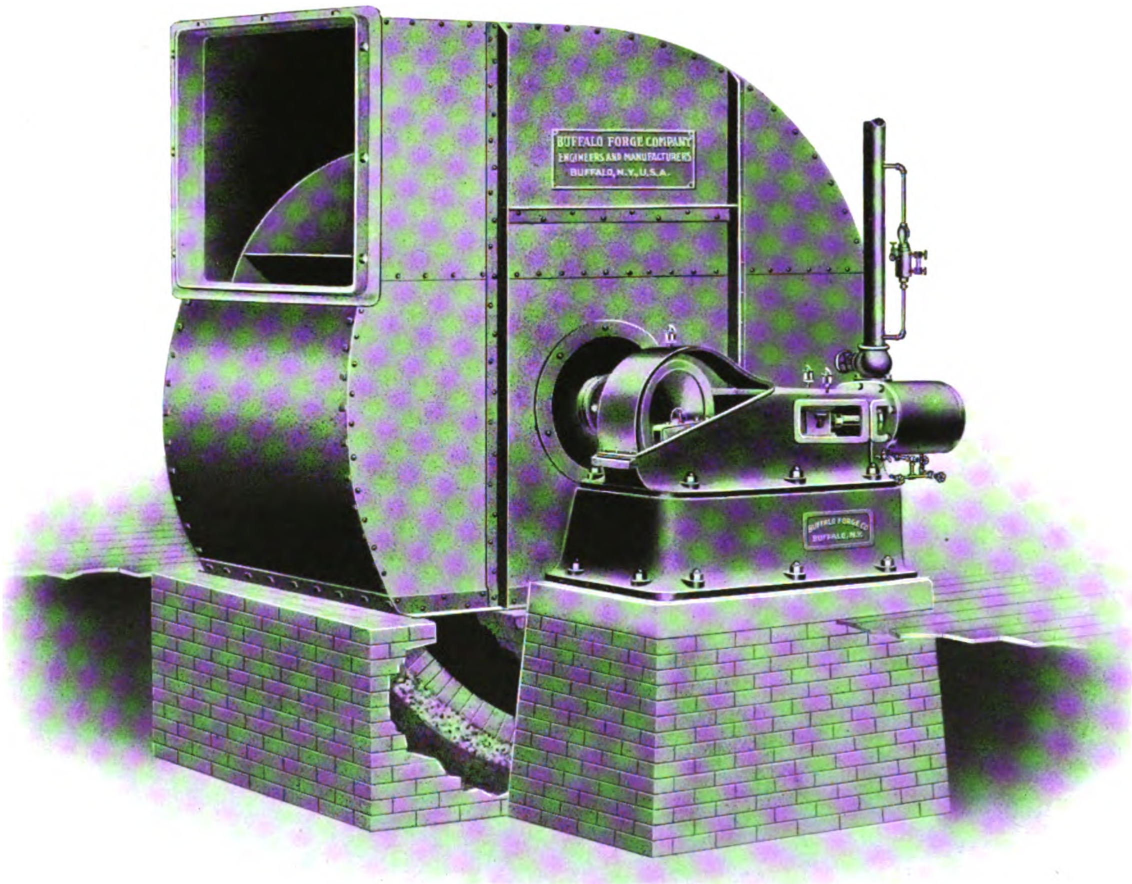
THREE-QUARTER HOUSING BOTTOM HORIZONTAL DISCHARGE FANS, DIRECT-CONNECTED TO BUFFALO HORIZONTAL CENTER-CRANK ENGINE.

SIZE OF ENGINE, INCHES.	SIZE OF FAN, INCHES.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R
5 x 6	100	67 3/4	37 1/4	27 1/2	46 1/8	43 3/8	48 7/8		48 1/4	46 1/4	25 1/2						37 1/2	
6 x 6	110	74 1/4	41	30 1/4	50 3/4	47 3/4	53 3/4		52	51 3/4	28						41 1/4	
6 x 8	120	79 5/8	44 3/4	31 7/8	55 3/8	52 1/8	58 5/8	50 5/8	55 3/4	55	30 1/8	41	15 1/4	17 1/4	9	12 3/4	45	36
7 x 8	130	87	48 1/2	35 1/2	60	56 1/2	63 1/2	50 5/8	59 1/2	60 3/4	33	43	15 1/4	17 1/4	9	12 3/4	48 7/8	36
8 x 8	140	93 1/4	52 1/4	38	64 5/8	60 7/8	68 3/8	50 5/8	63 1/4	64 3/4	35 1/8	45	15 1/4	17 1/4	9	12 3/4	52 5/8	36
8 x 10	150	99 1/4	56	40 1/4	69 1/4	65 1/4	73 1/4	65	67	69 1/2	37 1/2	52	20 1/4	21 1/2	12 1/2	16 1/4	56 3/8	40
8 x 10	160	105 3/8	59 3/4	42 5/8	73 7/8	69 5/8	78 1/8	65	70 3/4	74	41 1/4	53	20 1/4	21 1/2	12 1/2	16 1/4	60 1/8	40
9 x 10	170	112 1/2	63 1/2	46	78 1/2	74	83	65	74 1/2	79 1/4	43	55	20 1/4	21 1/2	12 1/2	16 1/4	63 7/8	40
10 x 10	180	118 3/4	67 1/4	48 1/2	83 1/8	78 3/8	87 7/8	65	78 1/4	84	45 3/4	57	20 1/4	21 1/2	12 1/2	16 1/4	67 5/8	40
10 x 12	190	125	71	51	87 3/4	82 3/4	92 3/4	82	82	88 1/2	47 3/4	64	22 5/8	24	14 7/8	20	71 3/8	52
11 x 12	200	131 1/4	74 3/4	53 1/2	92 3/8	87 1/8	97 5/8	82	85 3/4	92 1/2	49 5/8	66	22 5/8	24	14 7/8	20	75 1/8	52

These steam fans may be supplied with various sizes of horizontal engines, according to the steam pressures under which they are to operate, therefore the engine dimensions above given are necessarily variable.

Buffalo Mechanical Draft Apparatus

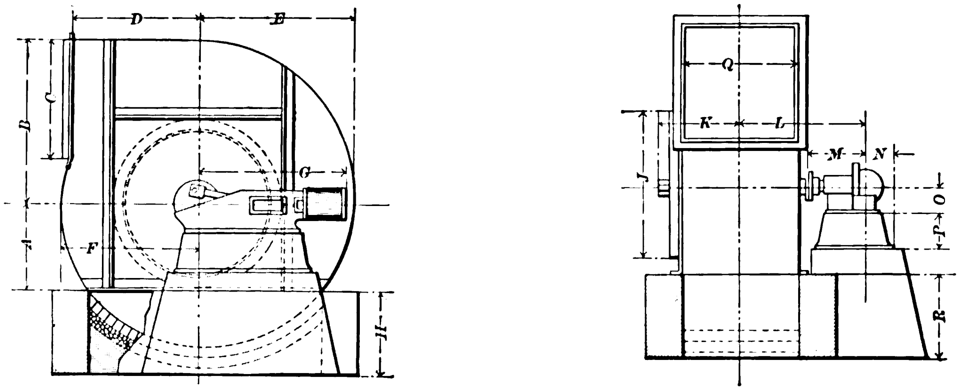
Steel Plate Fan with Buffalo Horizontal Side-crank Engine



Right-hand Three-quarter Housing Top Horizontal Discharge Fan Direct-connected to Side-crank Engine.

Buffalo Mechanical Draft Apparatus

Three-quarter Housing Steel Plate Fans with Buffalo Horizontal Side-crank Engines



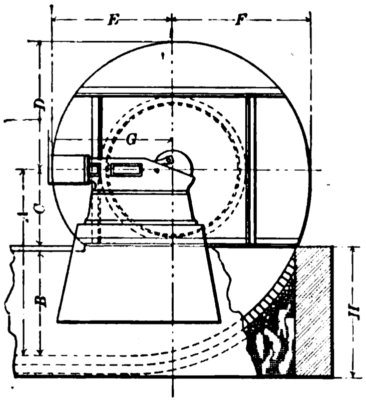
Steel Plate Three-fourth Housing Top Horizontal Discharge Fans Direct-connected to Buffalo Horizontal Side-crank Engines.

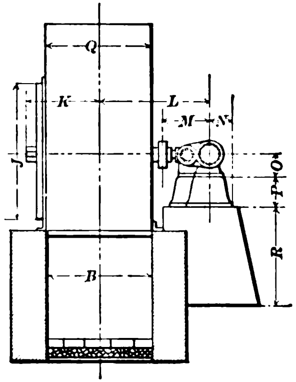
Size of Engine, Inches.	Size of Fan, Inches.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	Weight
5 x 6	100	27½	51⅝	37¼	40 5/16	48⅞	43⅜	45⅛	30	46¼	25½	49⅞	19⅜	10	8⅛	16	37¼	30	3460
6 x 6	110	30¼	56¾	41	44⅜	53¾	47¾	45⅛	30	51¾	28	52⅜	19⅜	10	8⅛	16	41	30	4320
6 x 8	120	31⅞	61⅞	44¾	48 7/16	58⅝	52⅛	55	36	55	30⅛	56⅝	21½	11⅜	9	18½	44¾	36	6325
7 x 8	130	35½	67	48½	52½	63½	56½	55	36	60¾	33	59½	21½	11⅜	9	18½	48½	36	7025
8 x 8	140	38	72⅛	52¼	56 9/16	68⅜	60⅞	55	36	64¾	35⅛	62⅛	21½	11⅜	9	18½	52¼	36	8382
7 x 10	150	40¼	77¼	56	60⅝	73¼	65¼	65	42	69½	37½	68½	25½	11¾	12	16	56	42	10456
8 x 10	160	42⅝	82⅜	59¾	64 11/16	78⅛	69⅝	65	42	74	41¼	72¼	25½	11¾	12	16	59¾	42	11079
9 x 10	170	46	87½	63½	68¾	83	74	65	42	79¼	43	74	25½	11¾	12	16	63½	42	12331
10 x 10	180	48½	92⅝	67¼	72 11/16	87⅞	78⅜	65	48	84	45¾	77¾	25½	11¾	12	16	67¼	48	13537
10 x 12	190	51	97¾	71	76⅞	92¾	82¾	81¾	48	88½	47¾	84	29¾	13½	14	19	71	48	16900
11 x 12	200	53½	102⅞	74¾	80 15/16	97⅝	87¼	81¾	51	92¼	49⅝	85⅞	29¾	13½	14	19	74¾	51	18900

Size of engine is based upon 80 pounds steam pressure. All dimensions given in inches. Dimension "J" refers to exhausters only. Tables of capacities given on pages 114 and 115.

Buffalo Mechanical Draft Apparatus

Three-quarter Housing Steel Plate Fans with Buffalo Side-crank Engines





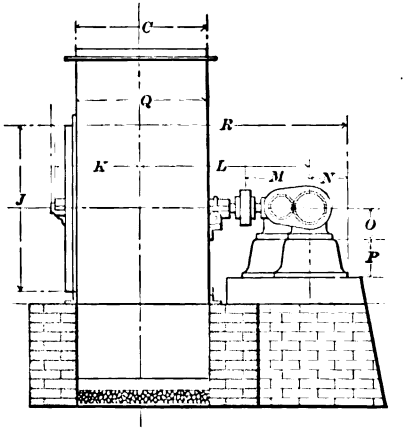
THREE-QUARTER HOUSING BOTTOM HORIZONTAL DISCHARGE FANS DIRECT-CONNECTED TO BUFFALO HORIZONTAL SIDE-CRANK ENGINES.

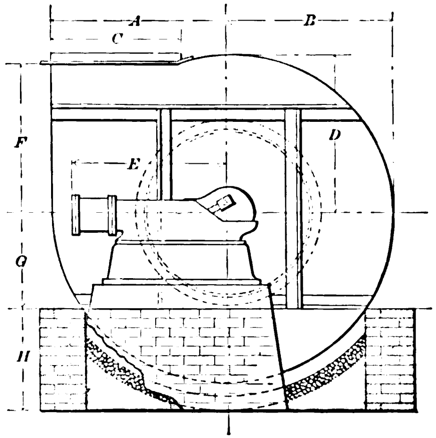
Size of Engine, Inches.	Size of Fan, Inches.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	Weight.
5 x 6	100	67¾	37¼	27½	46⅛	43⅜	48⅞	45⅛	48¼	46¼	25½	49⅞	19⅜	10	8⅛	16	37½	30	3460
6 x 6	110	74¼	41	30¼	50¾	47¾	53¾	45⅛	52	51¾	28	52⅜	19⅜	10	8⅛	16	41¼	30	4320
6 x 8	120	79⅝	44¾	31⅞	55⅜	52⅛	58⅝	55	55¾	55	30⅛	56⅝	21½	11⅜	9	18½	45	36	6325
7 x 8	130	87	48½	35½	60	56½	63½	55	59½	60¾	33	59½	21½	11⅜	9	18½	48⅞	36	7025
8 x 8	140	93¼	52¼	38	64⅝	60⅞	68⅜	55	63¼	64¾	35⅛	62⅛	21½	11⅜	9	18½	52⅝	36	8382
7 x 10	150	99¼	56	40¼	69¼	65¼	73¼	65	67	69½	37½	68½	25½	11¾	12	16	56⅜	42	10456
8 x 10	160	105⅜	59¾	42⅝	73⅞	69⅝	78⅛	65	70¾	74	41¼	72¼	25½	11¾	12	16	60⅛	42	11079
9 x 10	170	112½	63½	46	78½	74	83	65	74½	79¼	43	74	25½	11¾	12	16	63⅞	42	12331
10 x 10	180	118¾	67¼	48½	83⅛	78⅜	87⅞	65	78¼	84	45¾	77¾	25½	11¾	12	16	67⅝	42	13537
10 x 12	190	125	71	51	87¾	82¾	92¾	81¾	82	88½	47¾	84	29¾	13½	14	19	71⅜	48	16900
11 x 12	200	134¼	74¾	53½	92⅜	87⅛	97⅝	81¾	85¾	92¼	49⅝	85⅞	29¾	13½	14	19	75⅛	48	18900

These fans may be supplied with various sizes of engines, according to the steam pressures under which they are to operate, therefore the engine dimensions above given are necessarily variable. Size of engine given above is based on eighty pounds steam pressure. All dimensions given in inches.

Buffalo Mechanical Draft Apparatus

Three-quarter Housing Steel Plate Fans with Buffalo Side-crank Engines





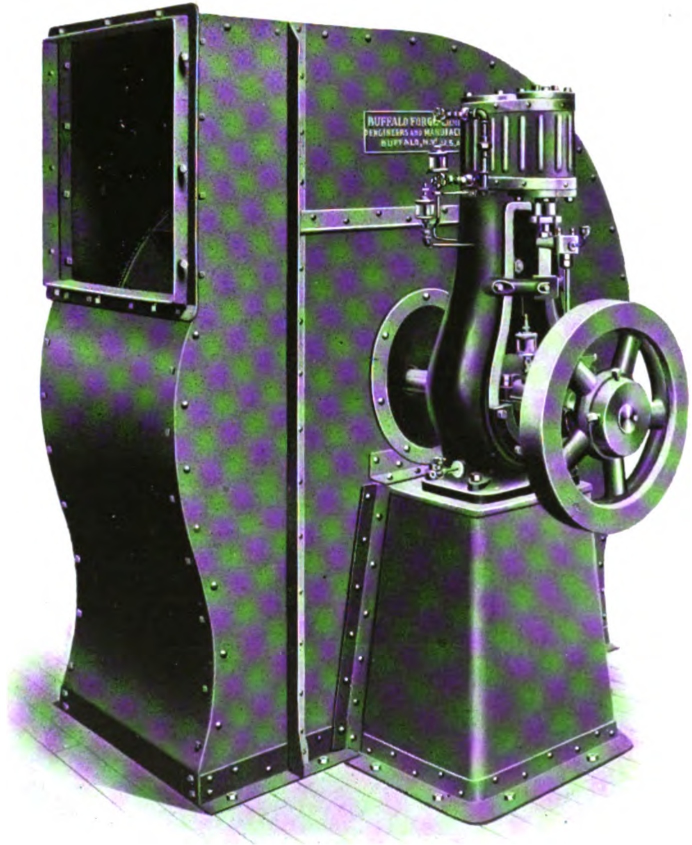
Three-quarter Housing Up Blast Discharge Fans Direct-connected to Buffalo Horizontal Side-crank Engines.

Size of Engine, Inches.	Size of Fan, Inches.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	Weight.
5 x 6	100	51 5/8	46 1/8	37 1/4	43 3/8	45 1/8	40 5/16	27 1/2	30	46 1/4	25 1/2	49 7/8	19 3/8	10	8 1/8	16	37 1/2	85 7/8	3460
6 x 6	110	56 3/4	50 3/4	41	47 3/4	45 1/8	44 3/8	30 1/4	30	51 3/4	28	52 3/8	19 3/8	10	8 1/8	16	41 1/4	90 7/8	4320
6 x 8	120	61 7/8	55 1/8	44 3/4	52 1/8	55	48 7/16	31 7/8	36	55	30 1/8	56 5/8	21 1/2	11 3/8	9	18 1/2	45	98 5/8	6325
7 x 8	130	67	60	48 1/2	56 1/8	55	52 1/2	35 1/2	36	60 3/4	33	59 1/2	21 1/2	11 3/8	9	18 1/2	48 7/8	104 3/8	7025
8 x 8	140	72 1/8	64 5/8	52 1/4	60 7/8	55	56 9/16	38	36	64 3/4	35 1/8	62 1/8	21 1/2	11 3/8	9	18 1/2	52 5/8	109 1/8	8382
7 x 10	150	77 1/4	69 1/4	56	65 1/4	65	60 5/8	40 1/4	42	69 1/2	37 1/2	68 1/2	25 1/2	11 3/4	12	16	56 3/8	118 1/4	10456
8 x 10	160	82 3/8	73 7/8	59 3/4	69 5/8	65	64 11/16	42 5/8	42	74	41 1/4	72 1/4	25 1/2	11 3/4	12	16	60 1/8	123 3/4	11079
9 x 10	170	87 1/2	78 1/2	63 1/2	74	65	68 3/4	46	42	79 1/4	43	74	25 1/2	11 3/4	12	16	63 7/8	120 1/4	12331
10 x 10	180	92 5/8	83 1/8	67 1/4	78 3/8	65	72 13/16	48 1/2	48	84	45 3/4	77 3/4	25 1/2	11 3/4	12	16	67 5/8	135 3/4	13537
10 x 12	190	97 3/4	87 3/4	71	82 3/4	81 3/4	76 7/8	51	48	88 1/2	47 3/4	84	29 3/4	13 1/2	14	19	71 3/8	145 3/4	16900
11 x 12	200	102 7/8	92 3/8	74 3/4	87 1/4	81 3/4	80 15/16	53 1/2	51	92 1/4	49 5/8	85 7/8	29 3/4	13 1/2	14	19	75 1/8	149 1/2	18900

Dimension "J" refers to exhausters only. Blowers have two inlets, each with a diameter equal "J" in the next lower size exhauster. Tables of capacities given on pages 114 and 115.

Buffalo Mechanical Draft Apparatus

Full Housing Steel Plate Fan with Buffalo Self-contained Upright Engine



Right-hand Top Horizontal Discharge Fan with Vertical Cylinder above Shaft Engine.

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Buffalo Single Upright Engines

The Buffalo Single Upright Engine direct-connected to the Steel Plate Fan combines many desirable features in its construction. The first of these fans and engines was built for the U. S. Navy. Briefly, the requirements of that specification were for a speed of 400 revolutions per minute at 160 pounds steam pressure, and of course the same high grade standard with reference to materials and workmanship required upon all Government work. The outfit proved eminently successful, and fulfilled more than was required of it.

This type of engine and fan has elsewhere been widely used for steam yachts, coasting vessels, and in fact every conceivable position where the requirements were for high speed, and a small compact arrangement. Many sizes are now built, the illustration on the opposite page being a four and one-half inch by a five-inch cylinder. These engines are built either with closed frames and self-oiling or with open frames, ring-oiling main bearing and ample provision of sight feed oil cups. With a good lubricant, seconded by care in adjustment, frictional losses may be reduced to an almost impossible minimum, ensuring cool, smooth running.

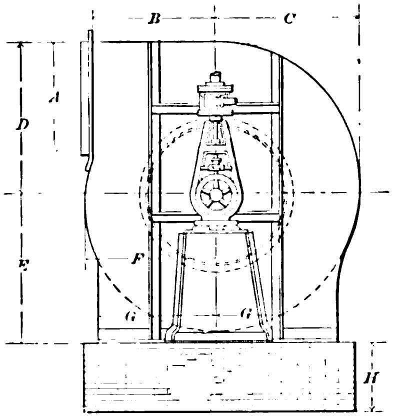
The engine is of the single double-acting type, furnished with a hand wheel. The ram box and eccentric rod are well proportioned. The whole outfit occupies the least possible space. Perfect lubrication is secured by large and continuous oilers at reciprocating points. The valve is of the balanced piston type. These engines are constructed both for high and low pressure, and are especially designed with reference to speed. There are several tables of outline dimensions of our standard fans on the accompanying pages. A close inspection of these tables will show the remarkable similarity existing in the proportions of all Buffalo Steel Plate Fans, and will also give an idea of the relatively small space required for a given fan output. Before the introduction of this engine, and other small engines herein described, all existing designs were inordinate steam consumers. Steam economy corresponding closely to that obtained in the highest grade power plants is now afforded by Buffalo high-speed engines.

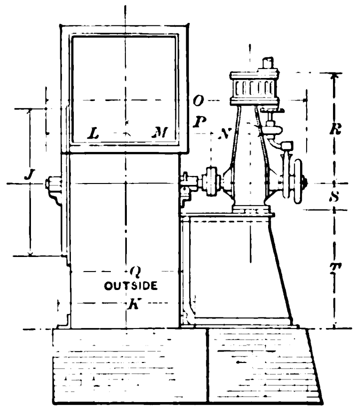
As to general structural features, these vertical engines resemble somewhat our horizontal type. The frame cylinder and valve chamber are all cast in one piece and the whole is so designed as to present a neat, graceful appearance. This construction does away with a number of joints and consequently reduces the possibility for the engine to get out of alignment, or become in any way deranged from loose nuts and bolts.

The bearings are all arranged with the Buffalo oil-ring device which has given such efficient service in all of the Buffalo Forge Apparatus. A more perfect bearing for rapidly rotating parts does not exist, the oil being constantly carried to the bearing surface by the oil-ring. A glance at the accompanying illustration will reveal the simplicity and compactness of design of this type of engine. Added to the economy of floor space are the advantages of copious lubrication, close regulation and excellent steam economy, thus ensuring efficient service under all conditions.

Buffalo Mechanical Draft Apparatus

Full Housing Fans with Cylinder above Shaft Engines



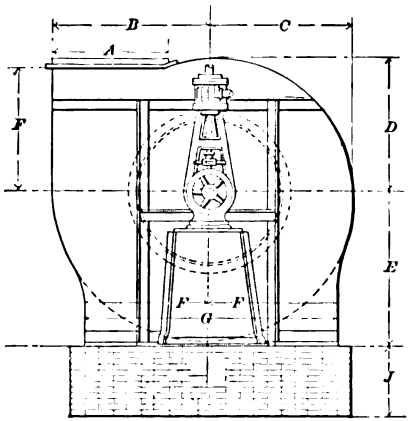


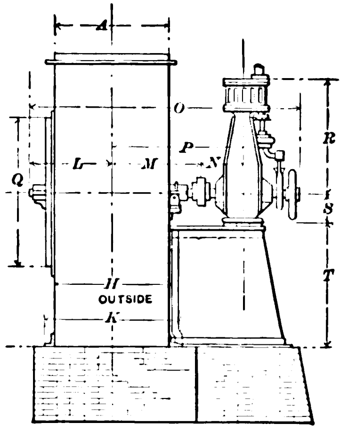
FULL HOUSING TOP HORIZONTAL DISCHARGE STEEL PLATE FAN DIRECT-CONNECTED TO VERTICAL CYLINDER ABOVE SHAFT ENGINE.

Size of Engine, Inches.	Size of Fan, Inches.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T
4 x 4	40	15	15 15/16	19 5/8	20 7/8	27	17 1/8	15 15/16	18	19	19					17 1/2	15 1/4	29	8 7/8	18 1/8
4 x 4	45	16 1/4	18	22 1/16	23 7/16	27	19 5/16	18	18	21 5/8	20 1/4					18 1/8	16 1/2	29	8 7/8	18 1/8
4 x 4	50	18 1/2	20	24 1/2	26	27	21 1/2	20	18	24 3/4	22 3/4					19 3/8	18 3/4	29	8 7/8	18 1/8
4 x 4	55	19 3/4	22	26 15/16	28 9/16	27	23 11/16	22	18	26 3/8	24					20	20 1/4	29	8 7/8	18 1/8
4 x 4	60	22 1/4	24 1/16	29 3/8	31 1/8	28	25 7/8	24 1/16	18	26 7/8	26 1/2					21 1/4	22 1/2	29	8 7/8	19 1/8
4 x 4	70	26	28 1/8	34 1/4	36 1/4	37 3/4	30 1/4	28 1/8	24	34 1/8	30 1/4					23 1/8	26 1/4	29	8 7/8	28 7/8
5 x 5	80	29 3/4	32 3/16	39 1/8	41 3/8	37 3/4	34 5/8	32 3/16	24	39 1/2	35	21 3/4	17 1/4	14 1/4	69 1/8	31 1/2	30	35 7/8	10	27 3/4
5 x 5	90	33 1/2	36 1/4	44	46 1/2	44	39	36 1/4	30	43 1/4	38 3/4	23 3/4	19 1/8	14 1/4	73	33 3/8	33 3/4	35 7/8	10	34
6 x 6	100	37 1/4	40 5/16	48 7/8	51 5/8	47	43 3/8	40 5/16	30	46 1/4	43 1/2	26	21	16 1/2	82	37 1/2	37 1/2	44	11	36
6 x 6	110	41	44 3/8	53 3/4	56 3/4	51	47 3/4	44 3/8	30	51 3/4	47 1/4	28 1/2	33	16 1/2	96 1/2	49 1/2	41 1/4	44	11	40
7 x 7	120	44 3/4	48 7/16	58 5/8	61 7/8	56	52 1/8	48 7/16	36	55	51	30 5/8	35 1/8	16 1/2	100 3/4	51 5/8	45	44	11	45
7 x 7	130	48 1/2	52 1/2	63 1/2	67	61	56 1/2	52 1/2	36	60 3/4	54 7/8	33 1/2	38	16 1/2	106 1/2	54 1/2	48 3/4	44	11	50
8 x 8	140	52 1/4	56 9/16	68 3/8	72 1/8	65 7/8	60 7/8	56 9/16	36	64 3/4	59 5/8	35 5/8	40 1/8	16 3/8	111 1/8	56 1/2	52 1/2	52 1/8	11 3/8	54 1/2
8 x 8	150	56	60 5/8	73 1/4	77 1/4	70 3/4	65 1/4	60 5/8	36	69 1/2	64 3/8	38	42 1/2	16 3/8	115 7/8	58 7/8	56 1/4	52 1/8	11 3/8	59 3/8

Buffalo Mechanical Draft Apparatus

Full Housing Fans with Cylinder above Shaft Engines



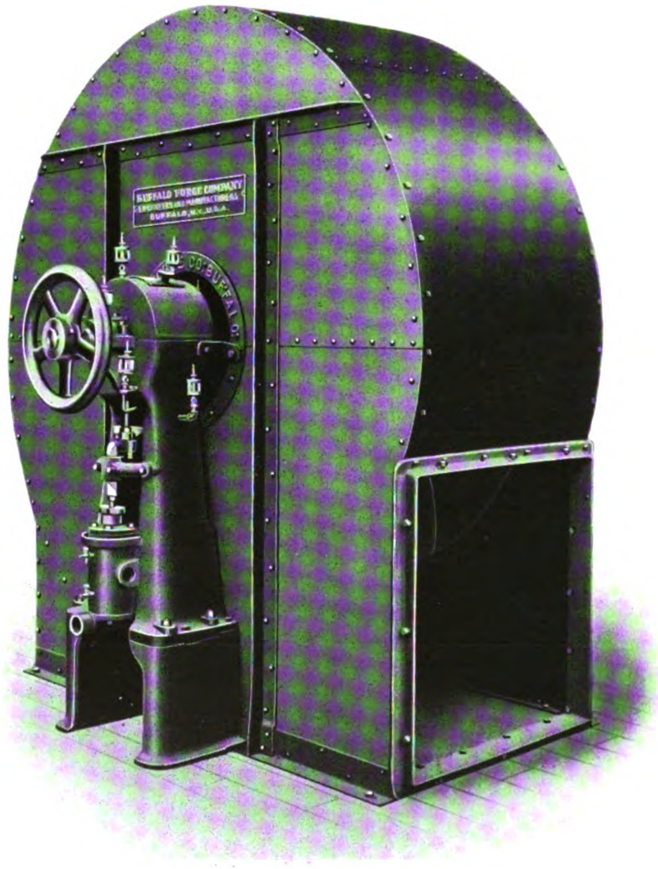


Full Housing Up Blast Discharge Steel Plate Fan, Direct-connected to Vertical Cylinder above Shaft Engine.

Size of Engine, Inches.	Size of Fan, Inches.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T
4 x 4	40	15	20 7/8	18 3/8	17 1/8	27	15 15/16	31 7/8	15 1/4	18	19					17 1/2	19	29	8 7/8	18 1/8
4 x 4	45	16	23 7/16	20 11/16	19 5/16	27	18	36	16 1/4	18	20 1/4					18 1/8	21 5/8	29	8 7/8	18 1/8
4 x 4	50	18 1/2	26	23	21 1/2	27	20	40	18 3/4	18	22 3/4					19 3/8	24 3/4	29	8 7/8	18 1/8
4 x 4	55	19 3/4	28 9/16	25 5/16	23 11/16	28	22	44	20	18	24					20	26 3/8	29	8 7/8	19 1/8
4 x 4	60	22 1/4	31 1/8	27 5/8	25 7/8	30	24 1/16	48 1/8	22 1/2	18	26 1/2					21 1/4	26 7/8	29	8 7/8	21 1/8
4 x 4	70	26	36 1/4	32 1/4	30 1/4	37 3/4	28 1/8	56 1/4	26 1/4	24	30 1/4					23 1/8	34 1/8	29	8 7/8	28 7/8
5 x 5	80	29 3/4	41 3/8	36 7/8	34 5/8	40	32 3/16	64 3/8	30	24	35	21 3/4	17 1/4	14 1/4	69 1/8	31 1/2	39 1/2	35 7/8	10	30
5 x 5	90	33 1/2	46 1/2	41 1/2	39	45	36 1/4	72 1/2	33 3/4	30	38 3/4	23 3/4	19 1/8	14 1/4	73	33 3/8	43 1/4	35 7/8	10	35
6 x 6	100	37 1/4	51 5/8	46 1/8	43 3/8	50	40 5/16	80 5/8	37 1/2	30	43 1/2	26	21	16 1/2	82	37 1/2	46 1/4	44	11	39
6 x 6	110	41	56 3/4	50 3/4	47 3/4	55	44 3/8	88 3/4	41 1/4	30	47 1/4	28 1/2	33	16 1/2	96 1/2	49 1/2	51 3/4	44	11	44
7 x 7	120	44 3/4	61 7/8	55 3/8	52 1/8	60	48 7/16	96 7/8	45	36	51	30 5/8	35 1/8	16 1/2	100 3/4	51 5/8	55	44	11	49
7 x 7	130	48 1/2	67	60	56 1/2	65	52 1/2	105	48 3/4	36	54 7/8	33 1/2	38	16 1/2	106 1/2	54 1/2	60 3/4	44	11	54
8 x 8	140	52 1/4	72 1/8	64 5/8	60 7/8	69	56 9/16	113 1/8	52 1/2	36	59 5/8	35 5/8	40 1/8	16 3/8	111 1/8	56 1/2	64 3/4	52 1/8	11 3/8	57 5/8
8 x 8	150	56	77 1/4	69 1/4	65 1/4	74	60 5/8	121 1/4	56 1/4	36	64 7/8	38	42 1/2	16 3/8	115 7/8	58 7/8	69 1/2	52 1/8	11 3/8	62 5/8

Buffalo Mechanical Draft Apparatus

Full Housing Fan with Self-contained Upright Engine



Left-hand Bottom Horizontal Discharge Fan with Cylinder Below Shaft Engine.

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Self-contained Upright Engines

Steel Plate Steam Fans, as will readily be seen, possess marked advantages over belt-driven ones, inasmuch as they may be run at any time, at any speed, and independent of other power. The volume and pressure of air can be changed instantly, and belts and pulleys are also avoided. Under many conditions of applications, the use of pulley fans would involve intricate arrangements in the transmission of power, which are entirely eliminated by the use of a direct-connected engine. As these machines are built both as blowers and exhausters, together with engines adapted for all conditions, the uses for which they are employed are almost unlimited in number. They have been introduced into thousands of situations with pre-eminent success.

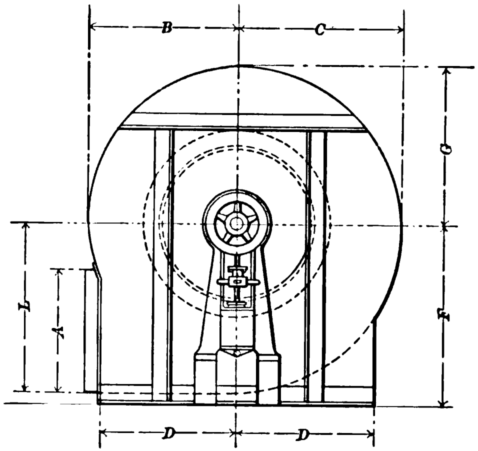
The vertical cylinder below shaft engines have their crosshead guides cast to a part of the frame. The guides are bored at the same time that the cylinder is bored, so that the alignment is perfect. The main bearings are large and well oiled with the Buffalo ring-oiling bearings. The cylinder and valve chest are also cast integral with the frame. They are accurately bored to standard size, while the parts are of ample area and are in addition short and direct, to reduce the clearance to a minimum. The steam chest after boring is fitted with hard iron bushings. Valve bushings which may be cut or worn through long usage can be readily replaced. The whole design is such as to afford absolute rigidity and reliability.

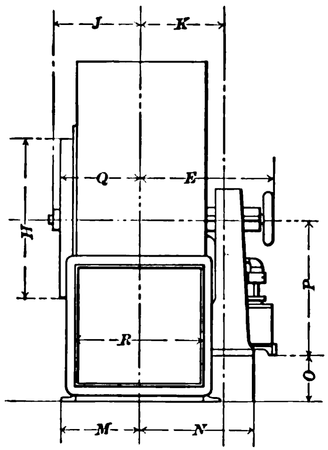
In situations requiring the use of a full housing steam fan, the single upright engine with cylinder below the shaft is ordinarily employed. Large fans for forced draft are usually built three-quarter housed, although they may be furnished in the full housing type with upright engines, either of the single or double form. As clearly illustrated by the accompanying engravings, our line of upright engines, both single and double, is replete with designs suitable for all conditions. Fans up to and including the 100-inch size may be supplied with the direct-connected Buffalo double single-acting upright enclosed engines running in oil, as per the engraving on page 74, and for dusty situations, high speed and continuous service, this form is peculiarly adapted. These engines direct-connected to full housing fans require and are furnished with a handsome sheet-steel sub-base. Many purchasers of steam fans below seventy inches in diameter prefer engines with cylinder above the shaft, and provision is made for this in both single and double types. The original type of Buffalo Steam Fan with single-acting upright engine has been replaced with more modern and efficient engine construction, and improvements, wherever possible, will always be made in the output of these works. Full details of the various designs will be preserved to the end of promptly supplying repairs.

In ordering a steam fan, or making inquiries as to prices, always be sure to state hand, the form of discharge and style of engine desired, the steam pressure carried at the boilers, and what work the fan is intended to perform. A drawing, showing the proposed setting position of the fan and all other details, will greatly facilitate the selection of the proper machine for the work.

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Buffalo Upright Cylinder Below Shaft Engine





Right–hand Bottom Horizontal Discharge Fan. Upright Self–contained Cylinder Below Shaft Engine.

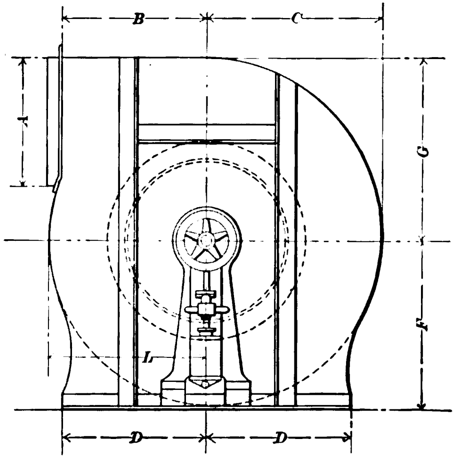
SIZE OF ENGINE BASED ON 80 POUNDS STEAM PRESSURE.

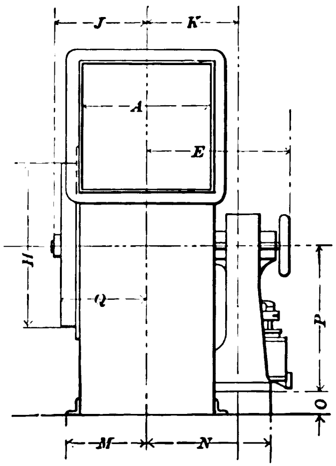
Size of Engine, Inches.	Size of Fan, Inches.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q
3 x 3 1/2	40	15	17 1/8	19 5/8	15 15/16	22 5/8	27	18 3/8	19	Overhung Wheel	12	20 7/8	9 1/2	17 3/8		27	9 3/8
3 x 3 1/2	45	16 1/4	19 5/16	22 1/16	18	23 1/4	27	20 11/16	21 5/8		12 5/8	23 7/16	10 1/8	18		27	10
3 x 3 1/2	50	18 1/2	21 1/2	24 1/2	20	24 3/8	27	23	24 3/4		13 3/4	26	11 3/8	19 1/8		27	11 3/4
4 x 3 1/2	55	19 3/4	23 11/16	26 15/16	22	25 1/4	29 11/16	25 5/16	26 3/8		14 5/8	28 9/16	12	20	2 11/16	27	12 3/8
4 x 3 1/2	60	22 1/4	25 7/8	29 3/8	24 1/16	26 1/4	32 3/8	27 5/8	26 7/8		15 5/8	31 1/8	13 1/4	21	5 3/8	27	13 3/4
4 1/2 x 5	70	26	30 1/4	34 1/4	28 1/8	32 1/2	37 3/4	32 1/4	34 1/8		18 1/2	36 1/4	15 1/8	25 1/2	2 3/4	35	15 5/8
4 1/2 x 5	80	29 3/4	34 5/8	39 1/8	32 3/16	34 3/8	43 1/8	36 7/8	39 1/2		20 3/8	41 3/8	17 1/2	27 3/8	8 1/8	35	18
4 1/2 x 5	90	33 1/2	39	44	36 1/4	36 1/4	48 1/2	41 1/2	43 1/4		22 1/4	46 1/2	19 3/8	29 1/4	13 1/2	35	19 7/8
5 1/2 x 7	100	37 1/4	43 3/8	48 7/8	40 5/16	39 1/2	53 7/8	46 1/8	46 1/4	25 1/2	25 1/4	51 5/8	21 3/4	33 3/4	12 1/2	41 3/8	20 3/4
6 1/2 x 8	110	41	47 3/4	53 3/4	44 3/8	45	59 1/4	50 3/4	51 3/4	28	27 3/4	56 3/4	23 5/8	36 1/2	12 1/4	47	22 5/8
6 1/2 x 8	120	44 3/4	52 1/8	58 5/8	48 7/16	46 7/8	64 5/8	55 3/8	55	30 1/8	29 5/8	61 7/8	25 1/2	38 3/8	17 5/8	47	24 1/2
6 1/2 x 8	130	48 1/2	56 1/2	63 1/2	52 1/2	48 3/4	70	60	60 3/4	33	31 1/2	67	27 7/16	40 1/4	23	47	26 3/8
7 1/2 x 9	140	52 1/4	60 7/8	68 3/8	56 9/16	53	75 3/8	64 5/8	64 3/4	35 1/8	34 1/8	72 1/8	29 13/16	44 3/8	20 3/8	55	28 1/4
7 1/2 x 9	150	56	65 1/4	73 1/4	60 5/8	54 7/8	80 3/4	69 1/4	69 1/2	37 1/2	36	77 1/4	32 3/16	46 1/4	25 3/4	55	30 1/8

All above fans are furnished with Buffalo Self-contained Upright Engines, and the fan wheels are overhung, excepting in the last six sizes. Different engine sizes are used for low steam pressures. In these cases, the dimensions above will not apply, but will be furnished upon application. Capacities, pages 114 and 115.

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Buffalo Upright Self-contained Engines





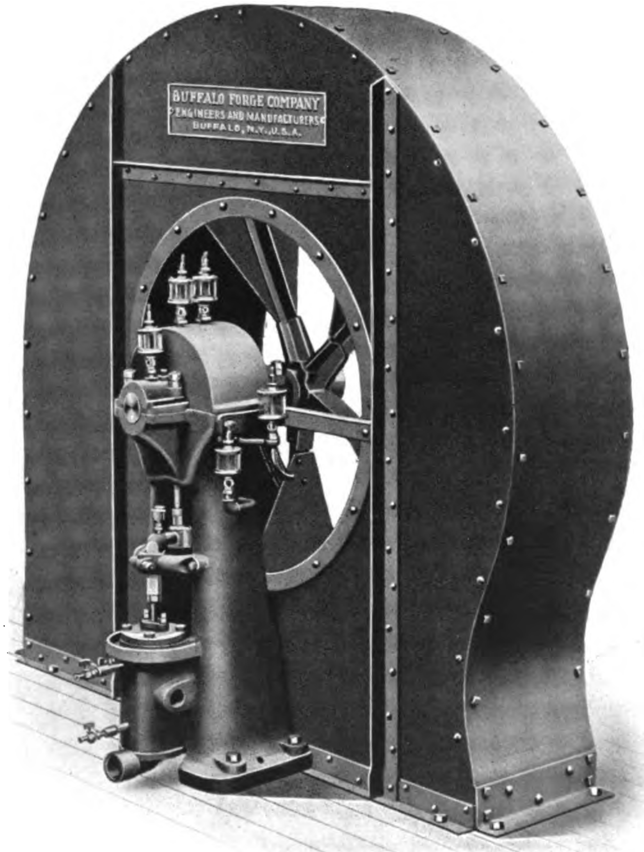
UPRIGHT SELF-CONTAINED CYLINDER BELOW SHAFT ENGINES. RIGHT-HAND TOP HORIZONTAL DISCHARGE.

SIZE OF ENGINE, INCHES.	SIZE OF FAN, INCHES.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q
3 x 1/2	40	15	15 15/16	19 5/8	15 15/16	22 5/8	27	20 7/8	19	OVERHUNG WHEEL.	12	17 1/8	9 1/2	17 3/8		27	9 3/4
3 x 3 1/2	45	16 1/4	18	22 1/16	18	23 1/4	27	23 7/16	21 5/8		12 5/8	19 5/16	10 1/8	18		27	10
3 x 1/2	50	18 1/2	20	24 1/2	20	24 3/8	27	26	24 3/4		13 3/4	21 1/2	11 3/8	19 1/8		27	11 3/4
4 x 3 1/2	55	19 3/4	22	26 15/16	22	25 1/4	27	28 9/16	26 3/8		14 5/8	23 11/16	12	20		27	12 3/8
4 x 3 1/2	60	22 1/4	24 1/16	29 3/8	24 1/16	26 1/4	28	31 1/8	26 7/8		15 5/8	25 7/8	13 1/4	21	1	27	13 3/4
4 1/2 x 5	70	26	28 1/8	34 1/4	28 1/8	32 1/2	37 3/4	36 1/4	34 1/8		18 1/2	30 1/4	15 1/8	25 1/2	2 3/4	35	15 5/8
4 1/2 x 5	80	29 3/4	32 3/16	39 1/8	32 3/16	34 3/8	37 3/4	41 3/8	39 1/2		20 3/8	34 5/8	17 1/2	27 3/8	2 3/4	35	18
4 1/2 x 5	90	33 1/2	36 1/4	44	36 1/4	36 1/4	44	46 1/2	43 1/4		22 1/4	39	19 3/8	29 1/4	9	35	19 7/8
5 1/2 x 7	100	37 1/4	40 5/16	48 7/8	40 5/16	39 1/2	47	51 5/8	46 1/4	25 1/2	25 1/4	43 3/8	21 3/4	33 3/4	5 5/8	41 3/8	20 3/4
6 1/2 x 8	110	41	44 3/8	53 3/4	44 7/8	45	51	56 3/4	51 3/4	28	27 3/4	47 3/4	23 5/8	36 1/2	4	47	22 5/8
6 1/2 x 8	120	44 3/4	48 7/16	58 5/8	48 7/16	46 7/8	56	61 7/8	55	30 1/8	29 5/8	52 1/8	25 1/2	38 3/8	9	47	24 1/2
6 1/2 x 8	130	48 1/2	52 1/2	63 1/2	52 1/2	48 3/4	61	67	60 3/4	33	31 1/2	56 1/2	27 7/16	40 1/4	14	47	26 3/8
7 1/2 x 9	140	52 1/4	56 9/16	68 3/8	56 9/16	53	65 7/8	72 1/8	64 3/4	35 1/8	34 1/8	60 7/8	29 13/16	44 3/8	10 7/8	55	28 1/4
7 1/2 x 9	150	56	60 5/8	73 1/4	60 5/8	54 7/8	70 3/4	77 1/4	69 1/2	37 1/2	36	65 1/4	32 3/16	46 1/4	15 3/4	55	30 1/8

All above fans are furnished with Buffalo Self-contained Upright Engines, and the fan wheels are overhung, excepting in the last six sizes. Different engine sizes are used for boiler pressures lower than eighty pounds. In these cases, the dimensions above will not apply, but will be furnished upon application.

Buffalo Mechanical Draft Apparatus

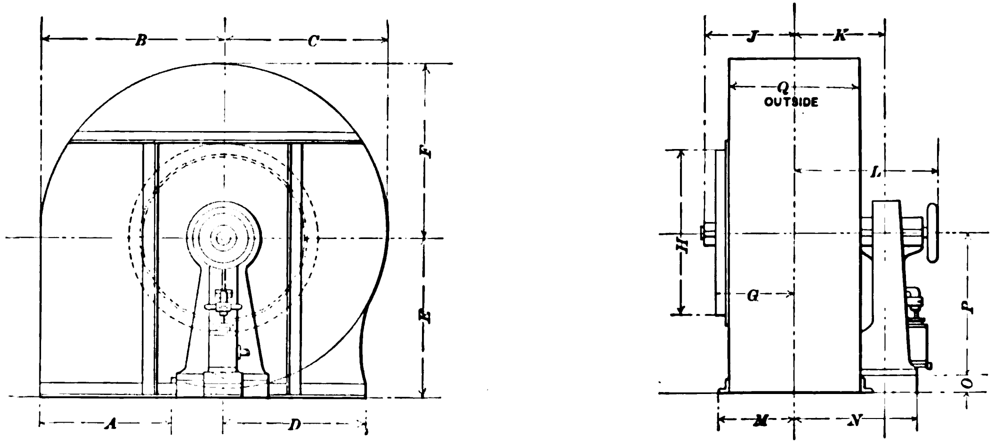
Steel Plate Fans with Buffalo Self-contained Engines



Right-hand Down Blast Discharge Blower, with Cylinder below Shaft Engine.

Buffalo Mechanical Draft Apparatus

Steel Plate Fans with Buffalo Upright Self-contained Engines



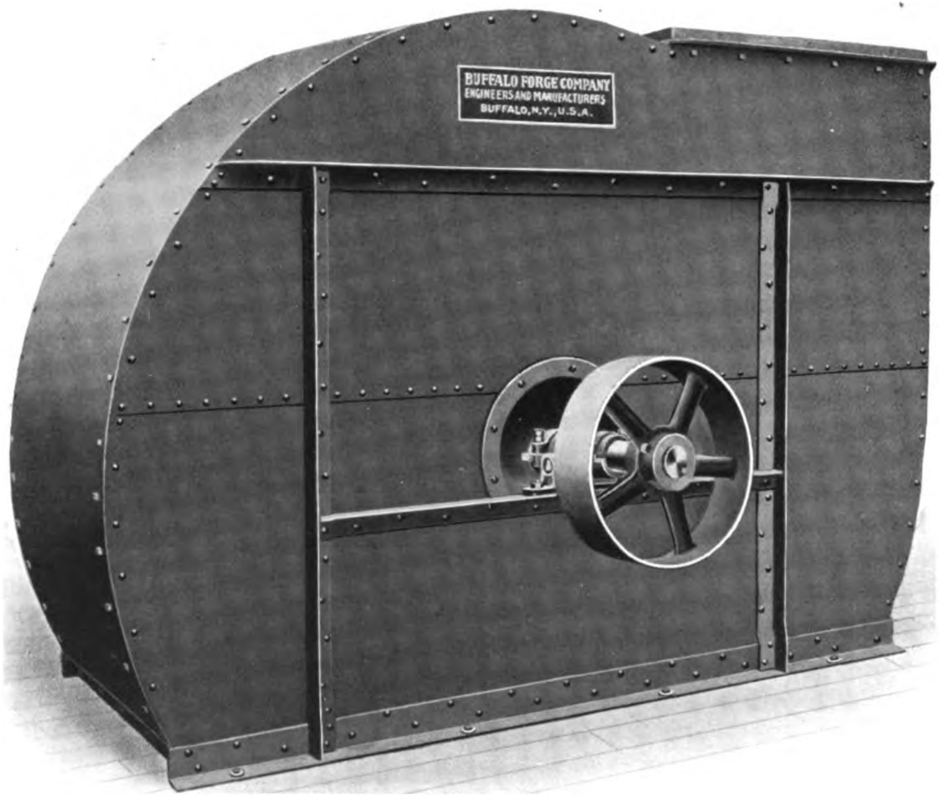
FULL HOUSING DOWN BLAST DISCHARGE FANS, DIRECT-CONNECTED TO SINGLE VERTICAL CYLINDER BELOW SHAFT ENGINES.

Size of Engine, Inches.	Size of Fan, Inches.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q
3 x 3 1/2	40	14 3/4	20 7/8	18 3/8	18 3/8	27	19 5/8	9 3/8	19	Overhung Wheel.	12	22 5/8	9 1/2	17 3/8		27	15
3 x 3 1/2	45	16	23 7/16	20 11/16	20 11/16	27	22 1/16	10	21 5/8		12 5/8	23 1/4	10 1/8	18		27	16 1/4
3 x 3 1/2	50	18 1/2	26	23	20	27	24 1/2	11 3/4	24 3/4		13 3/4	24 3/8	11 3/8	19 1/8		27	18 3/4
4 x 3 1/2	55	19 3/4	28 9/16	25 5/16	22	27	26 15/16	12 3/8	26 3/8		14 3/8	25 1/4	12	20		27	20
4 x 3 1/2	60	22 1/4	31 1/8	27 5/8	24 1/16	27	29 3/8	13 3/4	26 7/8		15 5/8	26 1/4	13 1/4	21		27	22 1/2
4 1/2 x 5	70	26	36 1/4	32 1/4	28 1/8	35	34 1/4	15 5/8	34 1/8		18 1/2	32 1/2	15 1/8	25 1/2		35	26 1/4
4 1/2 x 5	80	29 3/4	41 3/8	36 7/8	32 3/16	35 1/2	39 1/8	18	39 1/2		20 3/8	34 3/8	17 1/2	27 3/8	1/2	35	30
4 1/2 x 5	90	33 1/2	46 1/2	41 1/2	36 1/4	40	44	19 7/8	43 1/4		22 1/4	36 1/4	19 3/8	29 1/4	5	35	33 3/4
5 1/2 x 7	100	37 1/4	51 5/8	46 1/8	40 5/16	44 1/2	48 7/8	20 3/4	46 1/4	25 1/2	25 1/4	39 1/2	21 3/4	33 3/4	3 1/8	41 3/8	37 1/2
6 1/2 x 8	110	41	56 3/4	50 3/4	44 3/8	49	53 3/4	22 5/8	51 3/4	28	27 3/4	45	23 5/8	36 1/2	2	47	41 1/4
6 1/2 x 8	120	44 3/4	61 7/8	55 3/8	48 7/16	53 1/2	58 5/8	24 1/2	55	30 1/8	29 5/8	46 7/8	25 1/2	38 3/8	6 1/2	47	45
6 1/2 x 8	130	48 1/2	67	60	52 1/2	58	63 1/2	26 3/8	60 3/4	33	31 1/2	48 3/4	27 7/16	40 1/4	11	47	48 7/8
7 1/2 x 9	140	52 1/4	72 1/8	64 5/8	56 9/16	61 1/2	68 3/8	28 1/4	64 3/4	35 1/8	34 1/8	53	29 13/16	44 3/8	6 1/2	55	52 5/8
7 1/2 x 9	150	56	77 1/4	69 1/4	60 5/8	66	73 1/4	30 1/8	69 1/2	37 1/2	36	54 7/8	32 3/16	46 1/4	11	55	56 3/8

These steam fans may be supplied with various sizes of horizontal engines, according to the steam pressures under which they are to operate, therefore the engine dimensions above given are necessarily variable.

Buffalo Mechanical Draft Apparatus

Three-quarter Housing Steel Plate Fan



Left-hand Three-quarter Housing Up Blast Discharge Pulley Fan.

Buffalo Mechanical Draft Apparatus

Three-quarter Housing Steel Plate Fans

Buffalo Three-quarter Housing Fans are built either right or left hand in any of the discharges given for the full housing fans. The more common forms, however, are botton horizontal, top horizontal, and up blast. The last, illustrated by the engraving on page 94, is often used to exhaust smoke and gases from boiler fires. A top horizontal discharge fan is naturally selected when the sheet steel main breeching is run overhead, and underneath the ceiling, from which place it passes through the wall to a brick stack built on the outside. The up blast discharge, alike in three-quarter housing and full housing fans, is peculiarly adapted to support the short sheet steel stacks generally employed with induced draft plants. These fans are used for the same variety of purposes as the full housing type. Extra heavy stock for the shells is employed, rigidly stayed and stiffened by heavy "T" irons placed on the sides of fans, which is shown by the illustration on the opposite page. Complete drawings for foundations and application are furnished with every order.

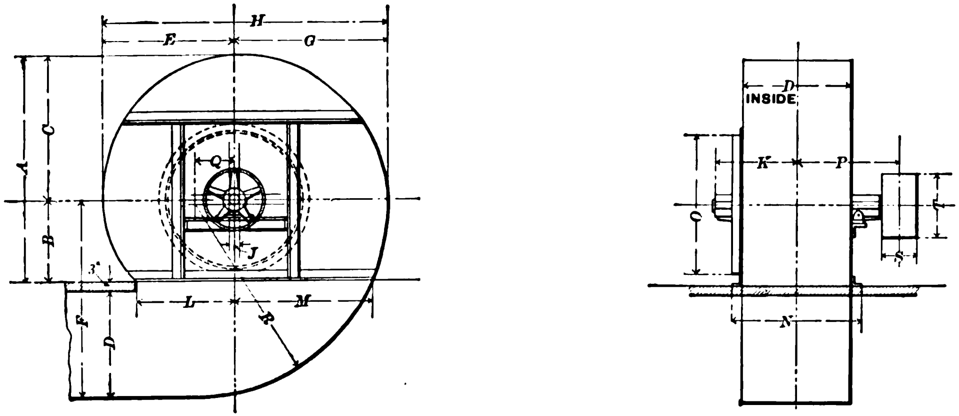
Buffalo Three-quarter Housing Steel Plate Fans are furnished with both side-crank and center-crank horizontal engines, as may be purchased, there being some difference in the cost. Attention is also further directed to the very compact and desirable arrangement afforded by the Buffalo Single Upright Engines, when direct-connected to a three-quarter housing fan. The cylinder being above the shaft, and the total height of the engine seldom exceeding the height of the shell, both the floor and head space are reduced to a minimum. A sub-base is not often required and no governor or fly-wheels are used on direct-connected fans and engines. Double Single-acting Engines, likewise equipped, are often used for small three-quarter housing fans.

In preference to a single fan, two Buffalo fans of equal capacity are often employed. Less vertical space is consumed, and as the fans when used for mechanical draft are commonly placed on a platform, the adopting of the double arrangement is often the only method of obtaining the required volume without building a special house for the apparatus, which would materially increase the installation cost. Two or more fans may be employed in connection with a common smokestack. In ordering or making inquiries about three-quarter housing steel plate fans, full details of the requirements should be given together with dimensions of the space available.

This house also builds a line of blowers, in general appearance and dimensions similar to those in the tables for the regular Buffalo Steel Plate Fans, but especially adapted for the various lines of iron and steel manufacture which require a larger volume of air than can be secured by the largest Buffalo "B" Volume Blowers, and at nearly as great a pressure as these fans are capable of furnishing. To meet the requirements of these conditions and to equal the high standard of durability and quiet running of all Buffalo blowers, extra heavy steel plate is selected, with shafts, wheels and foundation frames of increased stiffness and rigidity. Attention is called to an illustration of such a fan on page 92.

Buffalo Mechanical Draft Apparatus

Three-quarter Housing Steel Plate Blowers and Exhausters



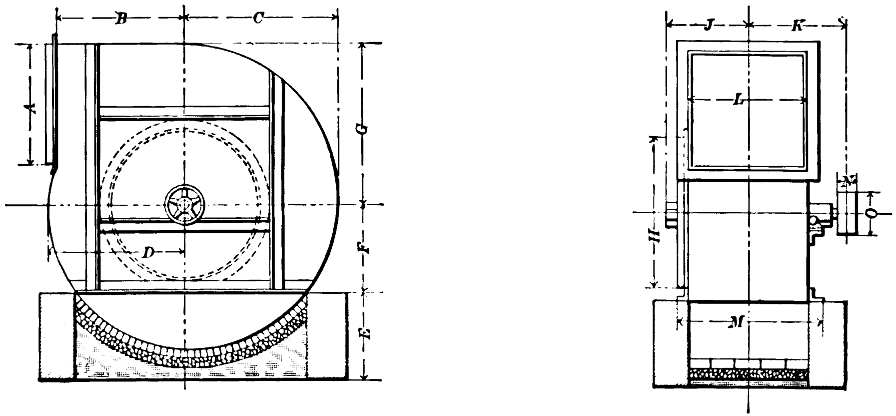
WITH OVERHUNG PULLEYS. RIGHT-HAND BOTTOM HORIZONTAL DISCHARGE.

SIZE IN INCHES.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T
190	138¾	51	87¾	71	82¾	125	92¾	175½	5	47¼	62½	82¾	83⅜	88½	53½	29¾	122½	14	34
200	145⅞	53½	92⅜	74¾	87⅛	131¼	97⅝	184¾	5¼	49⅛	65⅞	87⅛	87⅛	92½	55½	31	128⅝	15	36
210	153	56	97	78½	91½	137½	102½	194	5½	51	69½	91½		96½		32¼	134¾		38
220	160⅛	58½	101⅝	82¼	95⅞	143¾	107⅜	203¼	5¾		72¾	95⅞		100½		33½	140⅞		40
230	167¼	61	106¼	86	100¼	150	112¼	212½	6		76¼	100¼		104½		34¾	147		42
240	174⅜	63½	110⅞	89¾	104⅝	156¼	117⅛	221¾	6¼		79¾	104¾		108½		36	153⅛		44
250	181½	66	115½	93½	109	162½	122	231	6½		83¼	109⅛		112½		37¼	159¼		46
260	188⅝	68½	120⅛	97¼	113⅜	168¾	126⅛	240¼	6¾		86¾	113½		116½		38½	165⅜		48
270	195¾	71	124¾	101	117¾	175	131⅞	249½	7		90⅛	117⅞		120½		39¾	171½		50
280	202⅞	73½	129⅜	104¾	122⅛	181¼	136⅝	258¾	7¼		93⅝	122¼		124½		41	177⅝		52
290	210	76	134	108½	126½	187½	141½	268	7½		97⅛	126¾		128½		42¼	183¾		54
300	217⅛	78½	138⅝	112¼	130⅞	193¾	146⅜	277¼	7¾		100½	131⅛		132½		43½	189⅞		56
310	224¼	81	143¼	116	135¼	200	151¼	286½	8		104	135½		136½		44¾	196		58
320	231⅜	83½	147⅞	119¾	139⅝	206¼	156⅛	295¾	8¼		107½	139⅞		140½		46	202⅛		60
330	238½	86	152½	123½	144	212½	161	305	8½		110⅞	144¼		144½		47¼	208¼		62
340	245⅝	88½	157⅛	127¼	148⅜	218¾	165⅞	314¼	8¾		114⅜	148¾		148½		48½	214⅜		64
350	252¾	91	161¾	131	152¾	225	170¾	323½	9		117⅞	153⅛		152½		49¾	220½		66

Dimension "O" refers to exhausters only. Blowers have two inlets, each with a diameter equal "O" in the next lower size exhauster. A uniform ratio of proportions, dimensions and capacities exists throughout all sizes of Buffalo fans. All dimensions given in inches. Tables of capacities, pages 114 and 115.

Buffalo Mechanical Draft Apparatus.

Three-quarter Housing Steel Plate Blowers and Exhausters



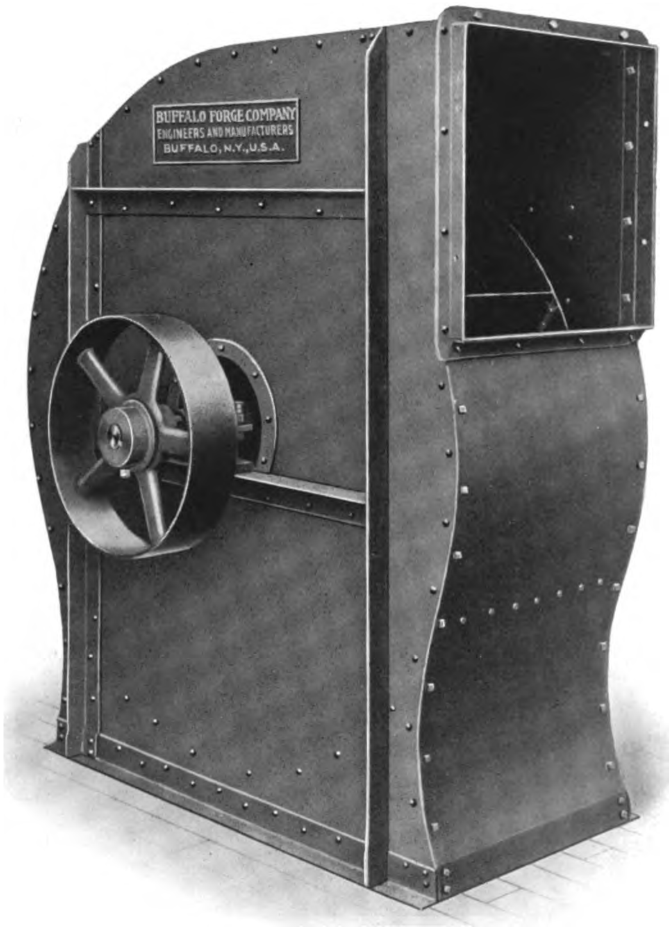
THREE–QUARTER HOUSING TYPE WITH OVERHUNG PULLEY. RIGHT–HAND TOP HORIZONTAL DISCHARGE.

SIZE IN INCHES.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	WEIGHT
50	18½	20	24½	21½	18	15⅜	26	24¾	14½	17⅜	18½	22¾	4	9	520
60	22¼	24 1/16	29⅜	25⅞	20	16 11/16	31⅛	26⅞	16⅞	19½	22¼	26½	5	10	647
70	26	28⅛	34¼	30¼	20	20⅞	36¼	34⅛	19¼	22	26	30¼	5	11	947
80	29¾	32 3/16	39⅛	34⅝	24	23½	41⅜	39½	21¼	24⅛	29¾	35	6	12	1347
90	33½	36¼	44	39	28	25½	46½	43¼	23¼	26½	33½	38¾	6	14	1896
100	37¼	40 5/16	48⅞	43⅜	30	27½	51⅝	46¼	25½	28⅞	37¼	43½	7	16	2384
110	41	44⅜	53¾	47¾	30	30¼	56¾	51¾	28	31⅝	41	47¼	7	18	2781
120	44¾	48 7/16	58⅝	52⅛	36	31⅞	61⅞	55	30⅛	34	44¾	51	8	20	3741
130	48½	52½	63½	56½	36	35½	67	60¾	33	36½	48½	54⅞	8	22	4459
140	52¼	56 9/16	68⅜	60⅞	36	38	72⅛	64¾	35⅛	39⅜	52¼	59⅝	9	24	5822
150	56	60⅝	73¼	65¼	42	40¼	77¼	69½	37½	42⅛	56	64⅜	10	26	7140
160	59¾	64 11/16	78⅛	69⅝	42	42⅝	82⅜	74	41¼	45⅛	59¾	86⅛	11	28	8054
170	63½	68¾	83	74	42	46	87½	79¼	43	47⅝	63½	71⅞	12	30	9207
180	67¼	72 13/16	87⅞	78⅜	48	48½	92⅝	84	45¾	50⅛	67¼	75⅝	13	32	10326
190	71	76⅞	92¾	82¾	48	51	97¾	88½	47¾	52¼	71	79⅜	14	34	11800
200	74¾	80 15/16	97⅝	87¼	51	53½	102⅞	94¼	49⅝	54¼	74¾	83⅛	15	36	13300

The three-quarter housing pulley fans may be furnished right or left hand, of any desired discharge, or to discharge in two or more directions. Dimension "H" in above table refers to exhausters only. Blowers have two inlets, each with a diameter equal "H" in the next lower size of exhauster.

Buffalo Mechanical Draft Apparatus

Full Housing Steel Plate Pulley Fan



Left-hand Top Horizontal Discharge Pulley Fan.

Buffalo Mechanical Draft Apparatus

Standard Full Housing Steel Plate Pulley Fans

Buffalo Steel Plate Fans are primarily designed to deliver a maximum amount of air with a minimum expenditure of power. Upon the design of scroll of the housing, and the relative proportion of the blast wheel, together with its form, depends, not only the amount of air per horse power a steel plate fan is capable of delivering, but its quietness of operation. Inlets and outlets of a fan play a most important part in the question of economy of power. It will readily be seen, therefore, that it is a matter of vital importance that these details be perfectly in proportion. Whenever the inlets or outlets of a fan are misproportioned, *i. e.*, considering the work the fan is to perform, much of the power applied is wasted.

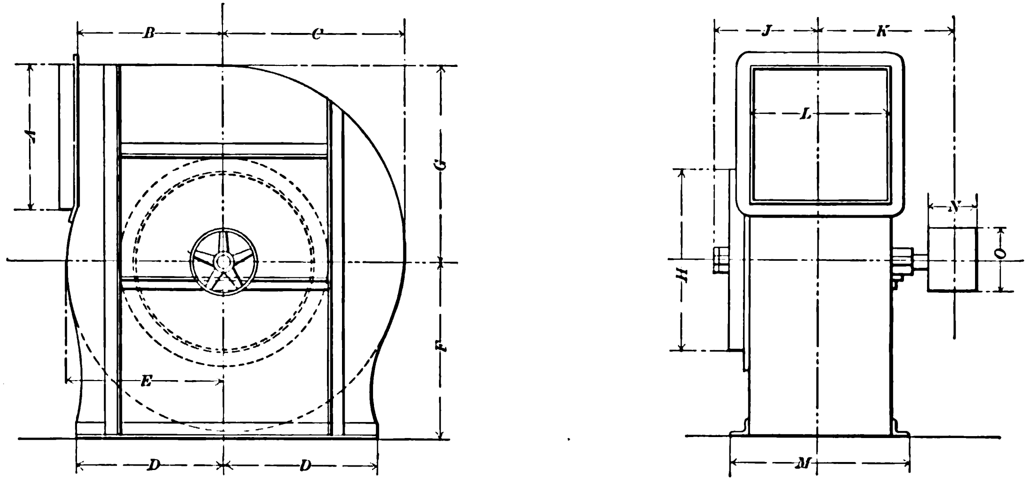
The standard of proportions of Buffalo Steel Plate Fans has been adopted as the outcome of a series of experiments extending over a number of years, with machines in actual use. The results secured warrant the assertion that better proportions do not exist. It is evident, from the work performed and power consumed, that such exhaustive experiments and tests with component parts of different proportions have never before been so systematically conducted. In every size of Buffalo Steel Plate Fans correct record of the indicated and actual power consumed under all speeds and variations of atmospheric conditions are preserved and the proper proportions of each component part have been brought down to the finest point. Every fan is thoroughly tested before leaving our works and found to equal the best results ever secured from an equal size, both as to capacity, power consumed and quiet running.

Buffalo Steel Plate Fans are built of homogeneous patent leveled and rolled steel sheets, free from buckles and of the greatest stiffness. Portions of the shell are riveted to angle irons and bolted together. Scrutiny of the several illustrations of steam and pulley fans appearing throughout the catalogue will result in a clear idea of the forms adopted for rigidly staying the fan cases, in the different sizes and designs for various work, so that they will run without vibration. Base angle iron foundation frames are supplied, all portions being strongly braced. The inlet rings are of cast iron. The bearing brackets are bolted to heavy steel angle irons. The bearings are swiveled to prevent springing of the shaft when the machine is bolted to a defective foundation; they are equipped with same oiling devices as illustrated on page 106, have large wearing surfaces, and are lined with genuine babbitt. The shafts are of cold rolled steel, of large diameter. The wheels are of the same material and workmanship as the celebrated Buffalo Steel Pressure Blower Blast Wheels, though the design of the steel plate fan wheel is different, being much narrower at the periphery.

These fans are regularly built both right or left hand, and to deliver air in any of the following forms: Bottom horizontal, top horizontal, up blast and down blast. They may be readily furnished in all sizes to discharge in any one or two angles, to suit all conditions of application. A very simple solution to an otherwise difficult problem is often found by using a special double discharge fan.

Buffalo Mechanical Draft Apparatus

Steel Plate Blowers and Exhausters



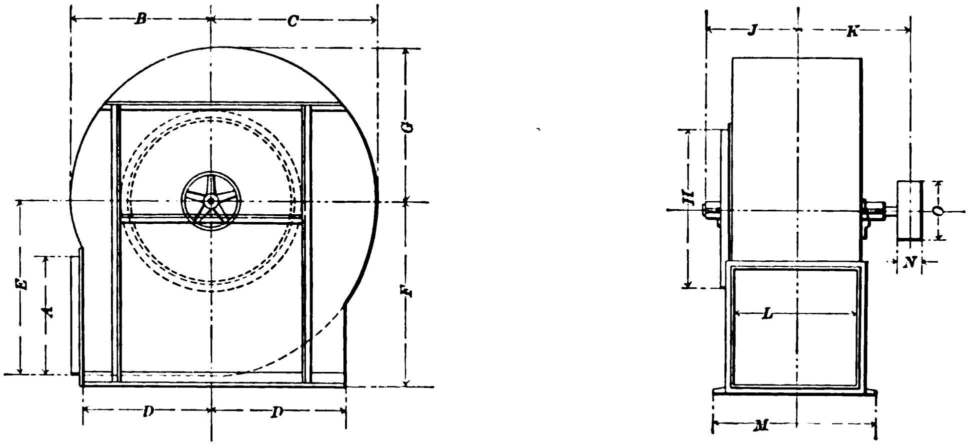
WITH OVERHUNG PULLEYS. RIGHT-HAND TOP HORIZONTAL DISCHARGE.

SIZE IN INCHES.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	WEIGHT
30	11¼	11⅞	14¾	11⅞	12¾	14½	15¾	14⅞	10⅜	11⅞	11¼	15¼	3	7	242
35	13½	13⅞	17 3/16	13⅞	14 15/16	16 13/16	18 5/16	17	11⅞	13⅜	13½	17½	3	7	300
40	15	15 15/16	19⅝	15 15/16	17⅛	19⅛	20⅞	19	12⅞	14⅜	15	19	3	8	399
45	16¼	18	22 1/16	18	19 5/16	21 7/16	23 7/16	21⅝	13⅝	15⅛	16¼	20¼	3	8	526
50	18½	20	24½	20	21½	23½	26	24¾	14½	17⅜	18½	22¾	4	9	654
55	19¾	22	26 15/16	22	23 11/16	26⅜	28 9/16	26⅜	15⅞	18½	19¾	24	4	9	734
60	22¼	24 1/16	29⅜	24 1/16	25⅞	28	31⅛	26⅞	16⅞	19½	22¼	26½	5	10	814
70	26	28⅛	34¼	28⅛	30¼	37¾	36¼	34⅛	19¼	22	26	30¼	5	11	1158
80	29¾	32 3/16	39⅛	32 3/16	34⅝	37¾	41⅜	39½	21¼	24⅛	29¾	35	6	12	1457
90	33½	36¼	44	36¼	39	44	46½	43¼	23¼	26½	33½	38¾	6	14	2143
100	37¼	40 5/16	48⅞	40 5/16	43⅜	47	51⅝	46¼	25½	28⅞	37¼	43½	7	16	2525
110	41	44⅜	53¾	44⅜	47¾	51	56¾	51¾	28	31⅝	41	47¼	7	18	3204
120	44¾	48 7/16	58⅝	48 7/16	52⅛	56	61⅞	55	30⅛	34	44¾	51	8	20	3865
130	48½	52½	63½	52½	56½	61	67	60¾	33	36½	48½	54⅞	8	22	4939
140	52½	56 9/16	68⅜	56 9/16	60⅞	65⅞	72⅛	64¾	35⅛	39⅜	52¼	59⅝	9	24	6105
150	56	60⅝	73¼	60⅝	65¼	70¾	77¼	69½	37½	42⅛	56	64⅜	10	26	7556

Dimension "H" refers to exhausters. Blowers have two inlets of equal area. A uniform ratio of proportions, dimensions and capacities exists throughout all sizes. See tables of capacities pages 114 and 115.

Buffalo Mechanical Draft Apparatus

Buffalo Steel Plate Pulley Fans

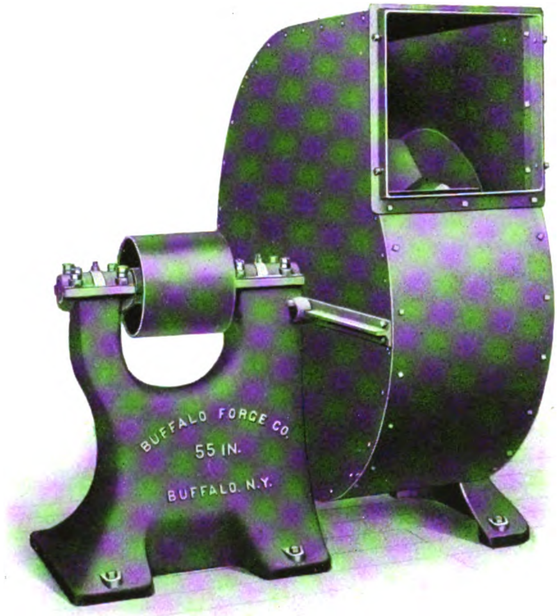


Right-hand Bottom Horizontal Discharge with Overhung Pulley.

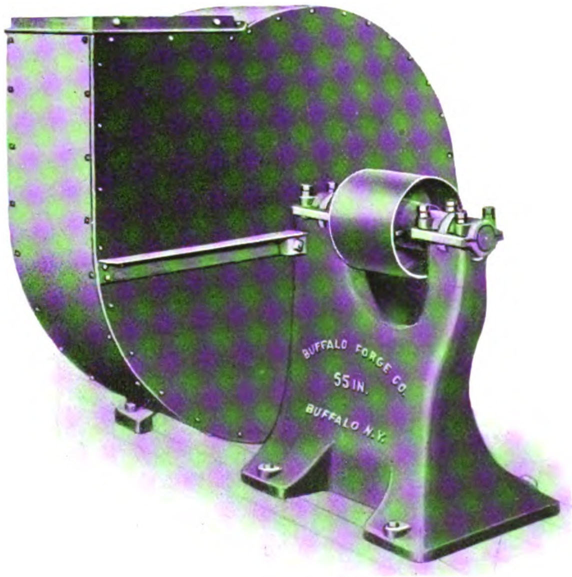
Size in Inches.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	Weight
30	11 1/4	12 3/4	14 3/4	11 7/8	15 3/4	16 1/4	13 3/4	14 7/8	10 3/8	11 7/8	11 1/4	15 1/4	3	7	242
35	13 1/2	14 15/16	17 3/16	13 7/8	18 5/16	18 15/16	16 1/16	17	11 7/8	13 3/8	13 1/2	17 1/2	3	7	300
40	15	17 1/8	19 5/8	15 15/16	20 7/8	21 5/8	18 3/8	19	12 7/8	14 3/8	15	19	3	8	399
45	16 1/4	19 5/16	22 1/16	18	23 7/16	24 5/16	20 11/16	21 5/8	13 5/8	15 1/8	16 1/4	20 1/4	3	8	526
50	18 1/2	21 1/2	24 1/2	20	26	27	23	24 3/4	14 1/2	17 3/8	18 1/2	22 3/4	4	9	654
55	19 3/4	23 11/16	26 15/16	22	28 9/16	29 11/16	25 5/16	26 3/8	15 7/8	18 1/2	19 3/4	24	4	9	734
60	22 1/4	25 7/8	29 3/8	24 1/16	31 1/8	32 3/8	27 5/8	26 7/8	16 7/8	19 1/2	22 1/4	26 1/2	5	10	814
70	26	30 1/4	34 1/4	28 1/8	36 1/4	37 3/4	32 1/4	34 1/8	19 1/4	22	26	30 1/4	5	11	1158
80	29 3/4	34 5/8	39 1/8	32 3/16	41 3/8	43 1/8	36 7/8	39 1/2	21 1/4	24 1/8	29 3/4	35	6	12	1457
90	33 1/2	39	44	36 1/4	46 1/2	48 1/2	41 1/2	43 1/4	23 1/4	26 1/2	33 1/2	38 3/4	6	14	2143
100	37 1/4	43 3/8	48 7/8	40 5/16	51 5/8	53 7/8	46 1/8	46 1/4	25 1/2	28 7/8	37 1/4	43 1/2	7	16	2525
110	41	47 3/4	53 3/4	44 3/8	56 3/4	59 1/4	50 3/4	51 3/4	28	31 5/8	41	47 1/4	7	18	3204
120	44 3/4	52 1/8	58 5/8	48 7/16	61 7/8	64 5/8	55 3/8	55	30 1/8	34	44 3/4	51	8	20	3865
130	48 1/2	56 1/2	63 1/2	52 1/2	67	70	60	60 3/4	33	36 1/2	48 1/2	54 7/8	8	22	4939
140	52 1/4	60 7/8	68 3/8	56 9/16	72 1/8	75 3/8	64 5/8	64 3/4	35 1/8	39 3/8	52 1/4	59 5/8	9	24	6105
150	56	65 1/4	73 1/4	60 5/8	77 1/4	80 3/4	69 1/4	69 1/2	37 1/2	42 1/8	56	64 3/8	10	26	7556

Dimension "H" refers to exhausters only. Blowers have two inlets, each with a diameter equal "H" in the next lower size exhauster. Tables of capacities, pages 114 and 115.

Fans, less than Eight Inches in Diameter, with Overhung Blast Wheels



Left-hand Top Horizontal Discharge Pulley Fan.



Right-hand Up Blast Discharge Pulley Fan.

Buffalo Mechanical Draft Apparatus

Buffalo Steel Plate Pulley Fans

The engraving on the opposite page illustrates the type selected for all work where a pulley fan less than eighty inches in diameter, or one with an overhung wheel, is required. This style of fan is applied for a multitude of uses, such as blowing boiler fires, any work requiring comparatively large capacities of air at quite high pressures, and for handling hot air and gases. The construction throughout is very heavy and substantial. For the latter use, water-cooling boxes are provided where desired and so ordered. The wheel being overhung upon the shaft, leaves the inlet entirely unobstructed, and the water-cooling boxes prevent heating of the journals. These fans, while regularly built as exhausters, may also be furnished with two inlets or as a blower. Right or left-hand fans with any angle of discharge may be obtained.

While the same general outside appearance as the planing-mill exhausters the wheels are constructed differently, being especially designed to handle large volumes of air with a minimum power expenditure. The boxes are adjustable and rigidly supported, and are of the well-known Buffalo patented oil-ring type.

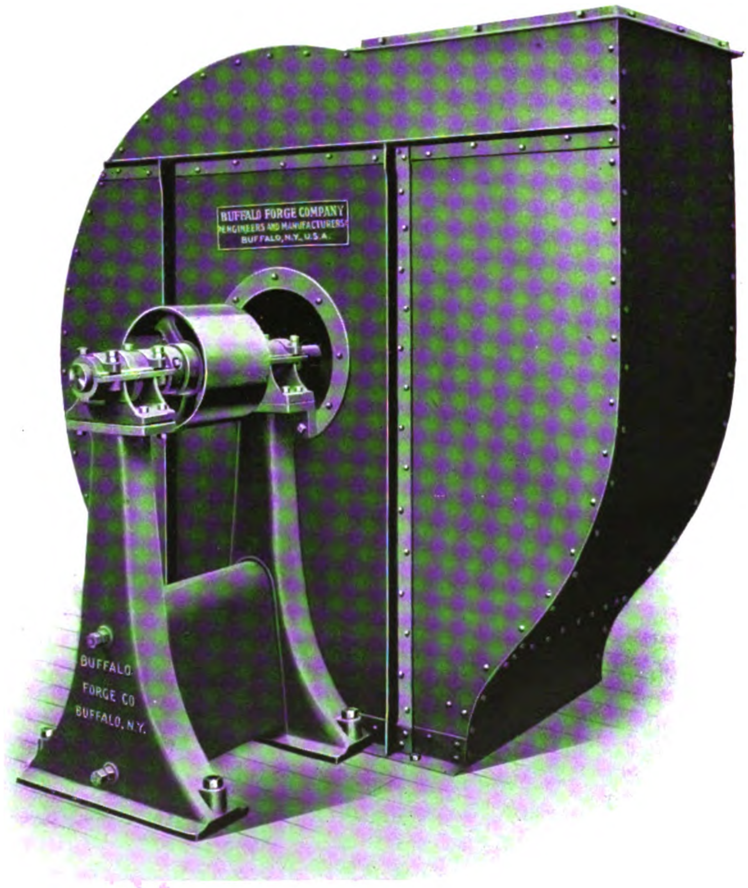
Buffalo Steel Plate Pulley Fans with overhung wheels are also built in the duplex types, *i. e.*, two fans driven by a single pulley between, where especially fitted to a given duty. This double construction results in no gain of pressure over the single type, its chief merits residing in its smaller vertical dimension. The external dimensions of both the single and double exhausters are practically the same as those given in the table for the steel plate fans, and these are sufficiently close for approximate estimates of space required. Fans with overhung wheels in all sizes less than 80 inches are built as shown on the opposite page. Larger sizes are constructed as shown on page 104. Sizes larger than those given in the table can be built to order if desired. Drawings of dimensions in detail will be supplied upon request of prospective customer.

The prime feature of the design of these exhausters, upon which letters patent have been obtained, is the ability to change the discharge of the machine by merely unloosening the bolts securing the case to the standard. The shell may then be turned to the desired discharge and again fastened to the standard. A right-hand bottom horizontal discharge, as shown by the engraving, changed to a top horizontal, would then become a left-hand machine. Both the single and double fans are built in the usual variety of discharges, which should be specified in ordering. The single exhausters are furnished either right or left hand.

In the majority of applications of large steel plate fans for any service, considerable can be gained in convenience of arrangement and economy of operation by building full-housing fans of the three-quarter housing type with special angular discharges. While it is not wise to depart from our standard fan construction, it is in many cases more convenient and more economical to employ a special angular discharge fan, and in some instances it is the only solution to the problem. These special discharge fans are arranged for driving by belt and pulley or with direct-connected steam engines.

Buffalo Mechanical Draft Apparatus

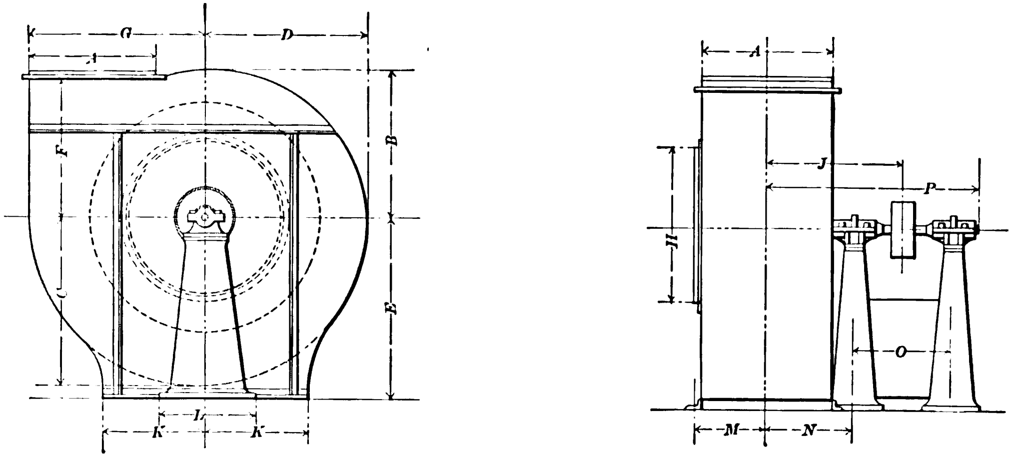
Fan, over Eighty Inches in Diameter, with Overhung Blast Wheel



Left-hand Up Blast Discharge Steel Plate Pulley Fan.

Buffalo Mechanical Draft Apparatus

Full-Housing Buffalo Steel Plate Blowers and Exhausters



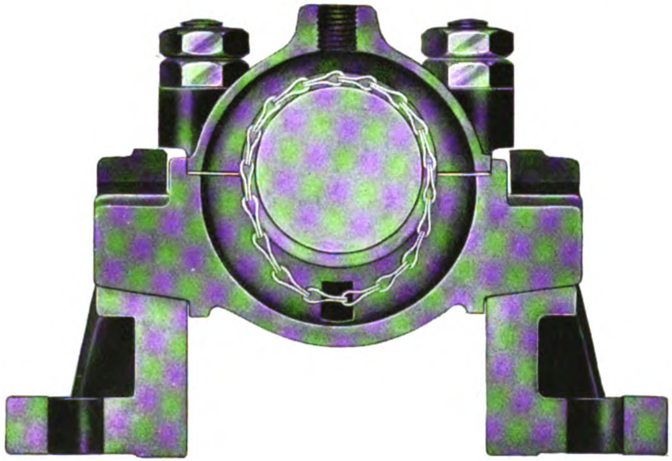
RIGHT-HAND UP BLAST DISCHARGE PULLEY FANS WITH OVERHUNG BLAST WHEELS.

Size in Inches.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Pulley Face	Pulley Diam.
30	11 1/4	12 3/4	14 3/4	13 3/4	15 3/4	11 7/8	15 3/4	14 7/8	14 3/4	10 1/4	12	6 3/4	8 3/4	12	23 3/4	3	6
35	13 1/2	14 15/16	17 3/16	16 1/16	18 5/8	13 7/8	18 5/16	17	17 3/8	12 1/8	13 3/4	7 7/8	10 3/8	14	27 7/8	3	7
40	15	17 1/8	19 5/8	18 3/8	22	15 15/16	20 7/8	19	18 13/16	14	15 3/4	8 5/8	11 1/8	15 3/8	30	3	8
45	16 1/4	19 5/16	22 1/16	20 11/16	24 1/4	18	23 7/16	21 5/8	20 3/8	15 1/2	17 1/2	9 1/4	12	16 3/4	32 1/2	4	9
50	18 1/2	21 1/2	24 1/2	23	27	20	26	24 3/4	22 1/2	18	19 3/4	10 1/2	13 1/2	18	35 1/2	4	10
55	19 3/4	23 11/16	26 15/16	25 5/16	29	22	28 9/16	26 3/8	24 1/8	19	21 1/4	11 1/8	14 1/2	19 1/4	38 1/8	5	11
60	22 1/4	25 7/8	29 3/8	27 5/8	30 7/8	24 1/16	31 1/8	26 7/8	26 1/8	21 3/4	24	12 3/8	15 7/8	20 1/2	40 7/8	6	11 1/2
70	26	30 1/4	34 1/4	32 1/4	37 3/4	28 1/8	36 1/4	34 1/8	27 5/8	22	28	14 1/4	16 1/8	23	45 1/8	7	12
80	29 3/4	34 5/8	39 1/8	36 7/8	43 1/8	32 3/16	41 3/8	39 1/2	29 1/2	25	28	16 3/8	18	23	47	8	14
90	33 1/2	39	44	41 1/2	48 1/2	36 1/4	46 1/2	43 1/4	31 3/8	27	28	18 1/4	19 7/8	23	48 3/8	9	16
100	37 1/4	43 3/8	48 7/8	46 1/8	53 7/8	40 5/16	51 5/8	46 1/4	39 1/4	28 1/2	26	20 1/2	24 1/4	30	59 3/4	10	18
110	41	47 3/4	53 3/4	50 3/4	59 1/4	44 3/8	56 3/4	51 3/4	41 1/8	31	26	22 3/8	26 1/8	30	62 5/8	12	20
120	44 3/4	52 1/8	58 5/8	55 3/8	64 5/8	48 7/16	61 7/8	55	43	33	26	24 1/4	28	30	62 1/2	14	22
130	48 1/2	56 1/2	63 1/2	60	70	52 1/2	67	60 3/4	45	37	26	26 1/8	30	30	66 1/8	16	24

Dimension "H" refers to exhausters only. Blowers have two inlets, each with a diameter equal "H" in the next lower size of exhauster. All dimensions are given in inches. Capacities on pages 114 and 115.

Buffalo Mechanical Draft Apparatus

Buffalo Chain-ring Self-oiling Bearings



Cross Section through Bearing, showing the Oil Chamber, Chain-ring and end of Shaft.

Sectional View of Chain-ring Oiling Bearing, showing the Shaft, Babbitt Lining, Chain-ring and Oil Chamber.

Buffalo Mechanical Draft Apparatus

Steel Plate Fan Wheels and Chain-ring Bearings

Buffalo Chain-ring Bearing is so well illustrated on the accompanying page, that a description of it is hardly necessary. This style of bearing has been employed upon all of the Buffalo Forge Company's apparatus, and has always given efficient service and entire satisfaction. In fact, purchasers often emphasize in their specifications that they want the genuine Buffalo Ring Bearings. In shaft bearings of considerable diameter the chain is more often used than the ring. It has been found by experience and tests that for larger diameter of shaft the chain hugs the shaft and gives slightly better distribution of oil than the ring.

As will be readily appreciated, a more positive or perfect bearing for rapidly rotating parts does not exist. It has been employed upon all of our high speed engines, and where these have been installed in marine service where continuous operation at high speed was a necessary feature, the bearings have always stood the test, and have never given trouble with overheating. The device is entirely automatic in action, the oil being constantly carried around the shaft by the ring, as will be seen by reference to the cut; it is thus impossible for the bearings to be without lubrication while there is oil in the chamber. The oil is brought up upon the shaft by the action of the chain or ring, and runs along a slight groove cut in the babbitt bearing. It will be seen from the illustrations that arrangements are made for collecting any oil that may tend to work out of the bearing and return it to the oil chamber. This design makes a most efficient and economical oiling device. The ring operates perfectly quiet until the oil becomes low. When any noise is heard it may be taken as a signal for refilling. The bearings will run without injury for some time after the signal for refilling is noticed.

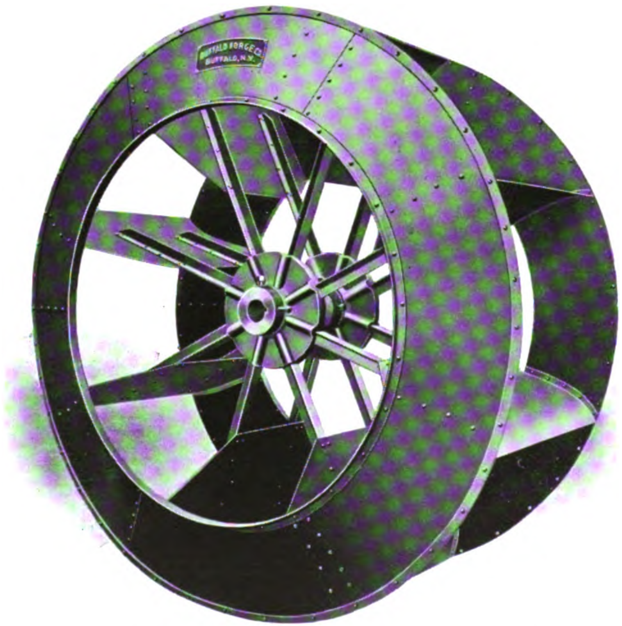
Buffalo Steel Plate Blast Wheels are illustrated on pages 108 and 109. Standard and Special Buffalo blast wheels are shown. Standard wheels have three forms of spiders, viz., single, double and triple spiders according to their diameter. These wheels are employed where it is desired to handle a large volume of air or gas at a moderate velocity, as a rule not exceeding one to one and a half ounces per square inch.

In mechanical draft installations a special design of spider is often necessary. Sometimes the fan wheels are overhung from the engine bearing, and if the wheel be of considerable size the spider is offset so as to bring the hub nearer to the supporting bearing. The spider of standard fan wheels are constructed of heavy angle irons cast into a cast-iron hub. It is a rigid and splendid construction. Instead of using tee-irons in the spider construction of the special wheels, the design now followed, especially in the smaller special wheels, is to make the spider direct from the vane. The steel plate from which the vane is to be made is folded and bent in such a manner that a very strong and neat-looking backbone is formed. This crease or backbone is properly riveted and the hub is so constructed that the spider fits neatly into it. The hub and vane are then securely fastened together with rivets, and the whole wheel when finished presents a very neat appearance and is substantial and efficient.

Buffalo Mechanical Draft Apparatus

Buffalo Steel Plate Fan Wheels

Buffalo Standard Three Spider Wheel.



Buffalo Standard Two Spider Wheel.

Buffalo Mechanical Draft Apparatus

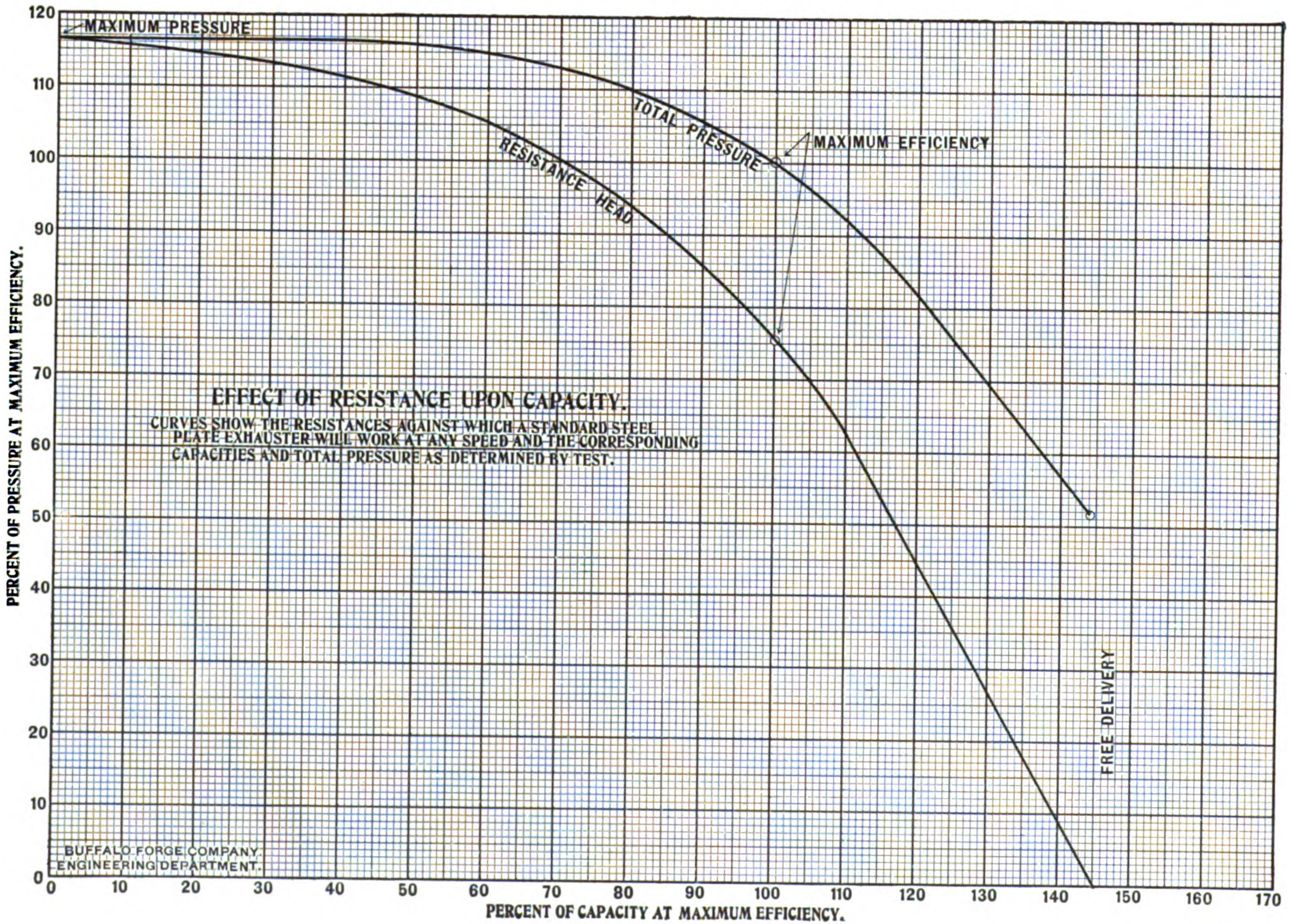
Buffalo Steel Plate Fan Wheels

Buffalo Standard Single Spider Wheel.

Buffalo Special Single Spider Wheel.

Buffalo Mechanical Draft Apparatus

Effect of Resistance Upon Capacity. Plate VII



Performance of Steel Plate Exhausters

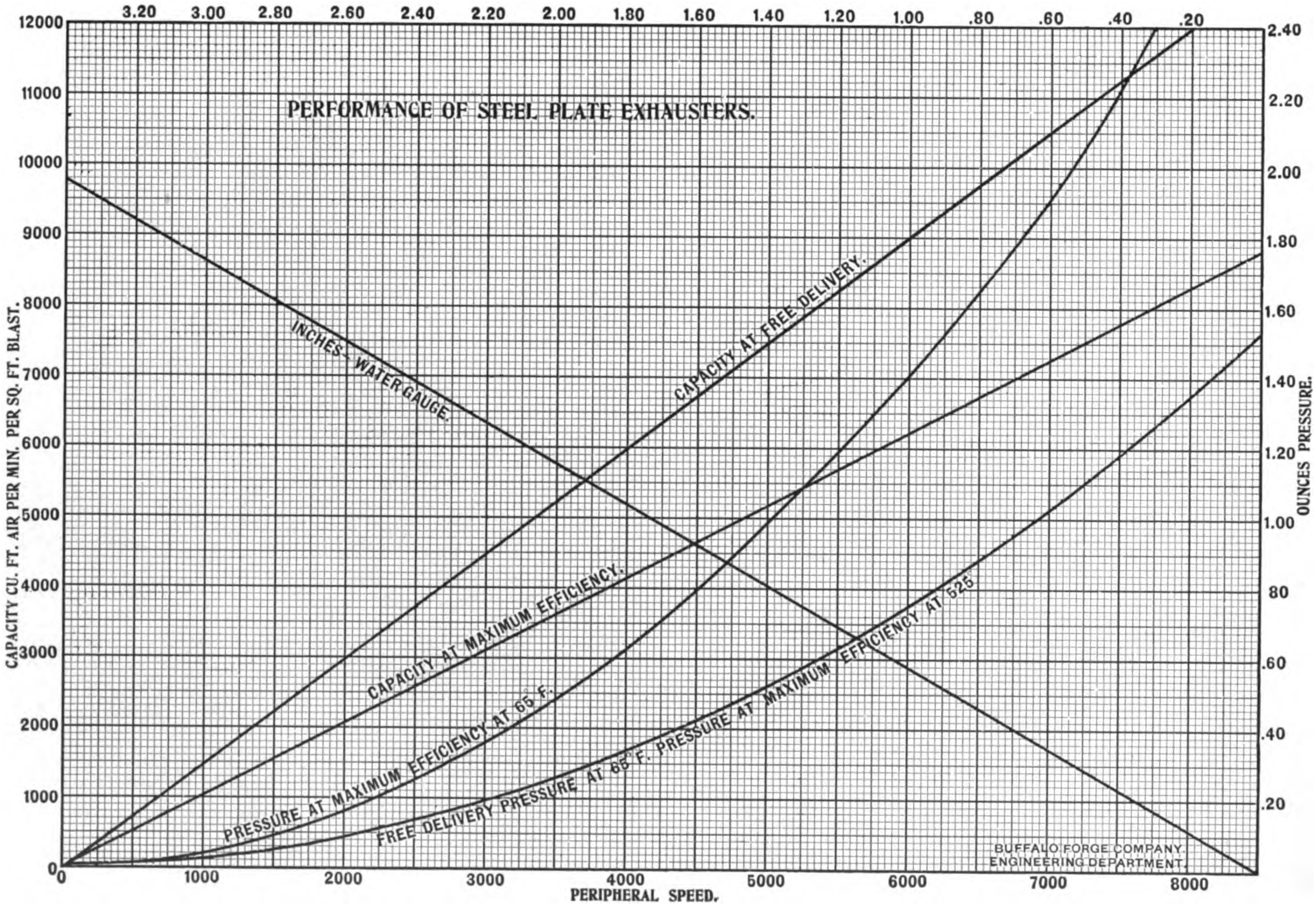
THE ACTUAL PERFORMANCE of a steel plate exhauster or other centrifugal fan, having a given rated capacity, is dependent first upon the temperature or density of the air or gases handled, and second, and more particularly, upon the conditions or resistance against which it must operate. At free delivery, the fan will give its maximum capacity, since the resistance against which it works is zero and the velocity pressure is low. As the resistance against which the fan is to operate, such as friction of air piping and heater coils or (in mechanical draft) the friction of the air through the bed of fuel, is increased, we find the capacity is likewise decreased, while the pressure and also the efficiency of the fan increase rapidly up to the point maximum efficiency. From this point the capacity decreases more rapidly than the pressure increases until we have reached a maximum pressure when the fan has ceased to discharge. Although the conditions under which a fan is required to operate are exceedingly varied, making it impossible to give any general rule or formula for determining size and speed of fan, yet where the conditions are known, it is always possible to select a fan of such size, which, when run at the proper peripheral speed, will give the desired capacity and pressure with a minimum amount of power, that is, a maximum efficiency of operation.

The importance of adapting the size and speed of the fan to the best working conditions appeals most clearly and forcibly to the engineer and purchaser, when it is understood that the power consumed by a fan increases in proportion to the cube of the speed, and that there is a great loss in efficiency in running a fan at either above or below its rated capacity. It is ever the aim of our engineering department to secure for our clients the best results by a careful adaptation of our apparatus to working conditions.

The curves on page 110, show the effect of resistance upon the capacity. The curve marked "Resistance Head" shows the static pressure or resistance against which the fan is working. The curve marked "Total Pressure" shows the total dynamic pressure and is equivalent to the static pressure plus the pressure corresponding to velocity. The horizontal spaces represent the performance of the fan at *any* peripheral speed, *i. e.*, its capacity under the given conditions relative to its rated capacity as given in tables on pages 115 at the corresponding peripheral speed. The vertical spaces represent the pressures or heads produced under these conditions in per cent. of the pressure which should be secured at maximum efficiency, or rated pressure at that peripheral speed according to tables on page 115. For example, suppose that a fan running at a certain peripheral speed is delivering 120% of its rated capacity at that speed; on curve marked "Total Pressure," we find the corresponding pressure to be 81½% of the rated pressure at that speed, and the resistance which the fan is overcoming is only 45% of the total pressure which should be secured at maximum efficiency. Under these conditions the fan consumes 2.22 times as much power per cubic foot of air delivered as would a fan properly proportioned for that pressure and volume.

Buffalo Mechanical Draft Apparatus

Performance of Steel Plate Exhausters. Plate VIII



Buffalo Mechanical Draft Apparatus

Performance of Steel Plate Exhausters

The curves on page 112 are designed to show performance of any steel plate exhauster, relative to capacity and pressure at any peripheral speed, both at free delivery and when operated under conditions of maximum efficiency. It will be noted that the capacity is directly proportional to the peripheral speed, which is the velocity of the outer rim of the blast wheel and is expressed in feet per minute. Further, it may be seen that while the capacity at free delivery is somewhat greater than the capacity at maximum efficiency, the pressure at maximum efficiency is approximately double the pressure at free delivery. The curve exhibiting the free delivery pressure at 65° Fahr. also represent the pressure maintained for any peripheral speed at maximum efficiency at 525° F. or at approximately the temperature of boiler flue gases. The line marked "Inches Water Gauge" serves to convert pressure expressed in inches by the water gauge to ounces pressure and conversant. As an illustration of the use of these curves, let it be required to determine what the peripheral speed of the fan must be in order to give 1.5 inches water gauge, first using air at 65° F., and second, flue gases at approximately 525° F. We find on the line marked inches—water gauge, corresponding to 1.5 in the column at the top of the page, a corresponding pressure .86 ounce. The corresponding point on the pressure point of maximum efficiency at 65° shows a peripheral speed of 4,700, and the capacity at maximum efficiency corresponding to this peripheral speed is 4,900 cubic feet of air per minute multiplied by a constant depending upon the size of the fan. If this pressure is desired in induced draft, we find that a peripheral speed of 6,400 on the curve pressure at maximum efficiency at 525° F. corresponds approximately to .86 ounce pressure or 1.5 inches water gauge and the capacity per square feet of blast is 6,600 cubic feet air per minute.

Great Economy of Power exists in moving a stated volume of air at a low velocity by a large fan as compared with the movement of the same quantity at a higher pressure by a smaller fan. A number of uses to which blowers are now applied with marked success require a large quantity of air at a comparatively high pressure. To accomplish the same work with one blower, we build a line of special fans. The dimensions and proportions are so varied as to fit them to a nicety for a given service. Where a heavy pressure of blast is called for, the fans are built with a much narrower wheel and with proportionately larger diameter.

In ordering steel plate fans, invariably state whether blowers or exhausters are desired, and the hand and discharge required. The hand of a fan is determined by the pulley being on the right or left side of the machine, standing looking into the outlet. Several forms of discharge are clearly shown by the various engravings.

Guarantee.—Buffalo Steel Plate Blowers and Exhausters are guaranteed to be built of the best material and workmanship, in a thoroughly workmanlike manner, to run with minimum power, to be most durable, to be so proportioned as to give the greatest suction and expulsive force obtainable.

Buffalo Mechanical Draft Apparatus

Capacity of Steel Plate Fans with Free Inlet and Outlet

SPEED OF FANS AND VOLUME OF AIR IN CUBIC FEET PER MINUTE AT 50° F. DISCHARGED INTO ATMOSPHERE WITH FREE INLET AND OUTLET AT VARIOUS PRESSURES IN OUNCES PER SQUARE INCH.

SIZE IN INCHES.	¼ OZ. PRES. 2585 VEL.		½ OZ. PRES. 3653 VEL.		¾ OZ. PRES. 4472 VEL.		1 OZ. PRES. 5161 VEL.		1½ OZ. PRES. 6315 VEL.		2 OZ. PRES. 7284 VEL.	
	REV.	VOL.	REV.	VOL.	REV.	VOL.	REV.	VOL.	REV.	VOL.	REV.	VOL.
30	448	1570	634	2220	775	2720	896	3140	1096	3840	1264	4440
35	387	2130	548	3020	671	3700	775	4260	947	5210	1091	6010
40	341	2800	481	3950	589	4830	686	5630	833	6830	960	7870
45	301	3440	430	4900	526	6000	607	6930	743	8480	957	9880
50	276	4030	388	5670	475	6940	548	8000	671	9800	774	11300
55	251	4970	355	7040	434	8600	502	9940	613	12100	708	14000
60	230	6310	325	8900	398	10900	459	12600	561	15400	650	17800
70	197	8540	280	12100	342	14800	394	17100	482	20900	557	24200
80	173	10900	245	15400	300	18800	346	21700	423	26600	488	30600
90	154	13800	218	19500	267	23800	308	27500	381	34000	435	38800
100	139	17700	197	25000	240	30500	278	35400	340	43200	392	50000
110	127	21100	179	29700	219	36400	254	41800	309	51400	357	59300
120	116	25700	164	36300	201	44500	232	51400	284	62800	328	72500
130	107	29700	152	42100	186	51600	214	59300	262	72400	302	83800
140	100	38400	141	49200	173	60400	199	69500	244	85200	282	88500
150	94	40200	132	56500	162	69400	186	79700	228	97700	263	112500
160	88	46200	124	65100	151	79400	174	91400	214	112000	247	130000
170	82	50900	116	72000	142	88200	164	102000	201	125000	232	144000
180	78	58600	110	82800	135	101500	155	116500	190	143000	220	165000
190	74	66200	104	93100	128	114500	148	132500	180	161000	208	186000
200	70	74200	99	150000	121	128000	140	148500	171	181000	198	210000
210	67	82330	94	115360	115	142430	133	164370	163	201130	188	231990
220	64	91740	90	129640	110	158710	127	183160	156	224120	180	258510
230	61	100800	86	143780	105	176020	122	203140	149	248560	172	286700
240	58	112200	83	158570	101	194140	118	224040	143	274140	165	316200
250	56	123150	79	173520	97	212420	112	245150	137	299960	158	345990
260	54	133050	76	190390	93	233210	108	269150	132	329330	152	379860
270	52	146630	74	207160	90	253610	104	292680	127	358120	146	413080
280	50	159150	71	225020	87	275470	100	317920	122	389000	141	448700
290	48	172050	68	242960	84	297430	97	343260	118	420010	136	484460
300	47	185550	66	262470	81	221313	94	370810	114	453730	132	523350
310	45	199690	64	282190	78	345460	91	398690	110	487830	128	562690
320	44	213450	62	302870	76	370770	88	427900	107	523580	124	603920
330	43	229160	60	323840	74	396440	85	457520	104	559830	120	645730
340	41	244660	58	345760	72	423270	82	488490	101	597720	116	689430
350	40	260590	57	368260	70	450820	80	520280	98	636610	113	734300

Buffalo Mechanical Draft Apparatus

Capacities of Steel Plate Fans Under Average Working Conditions

SPEED OF FANS AND VOLUME OF AIR IN CUBIC FEET PER MINUTE AT 50° F. DISCHARGED UNDER AVERAGE WORKING CONDITIONS AT VARIOUS PRESSURES IN OUNCES PER SQUARE INCH.

Size in Inches	¼ Oz. Pres. 2585 Vel.		½ Oz. Pres. 3653 Vel.		¾ Oz. Pres. 4472 Vel.		1 Oz. Pres. 5161 Vel.		1½ Oz. Pres. 6315 Rev.		2 Oz. Pres. 7284 Vel.	
	REV.	VOL.	REV.	VOL.	REV.	VOL.	REV.	VOL.	REV.	VOL.	REV.	VOL.
30	448	1059	634	1497	775	1833	896	2116	1096	2580	1264	2986
35	387	1447	584	2041	671	2500	775	2890	947	3475	1091	4080
40	341	1860	481	2625	589	3220	680	3710	833	4470	960	5240
45	301	2327	430	3292	526	4020	607	4640	743	5585	857	6550
50	276	2690	388	3800	475	4660	548	5360	671	6570	774	7570
55	251	3310	355	4680	434	5730	501	6600	613	8090	708	9320
60	230	4190	325	5920	398	7250	459	8320	561	10050	650	11800
70	197	5690	280	8040	342	9840	394	11340	482	13650	557	16010
80	173	7240	245	10210	300	12500	346	14450	423	17400	488	20400
90	154	9180	218	12950	267	15850	308	18300	381	22000	435	25800
100	139	11770	197	16610	240	20350	278	23500	340	28300	392	33200
110	127	14000	179	19750	219	24200	252	27950	309	33600	357	39400
120	116	17150	164	24200	201	29700	232	34300	284	41200	328	48300
130	107	19780	152	27900	186	34200	214	39500	262	47600	302	55800
140	100	23210	141	32800	173	40200	199	46400	244	55800	282	65500
150	94	26650	132	37700	162	46150	186	53200	228	65300	263	75100
160	88	30600	121	43250	151	53000	174	61100	214	74900	247	86200
170	82	34100	116	48100	142	59000	164	68100	201	83400	232	96000
180	78	38900	110	55000	135	67400	155	77700	190	95200	220	119500
190	74	44100	104	62300	128	76300	148	88000	180	106000	208	124000
200	70	49500	99	70000	121	85700	140	98900	171	119000	198	139500
210	67	54905	94	77700	115	94980	133	109440	163	134130	188	154710
220	64	61200	90	86460	110	105850	127	122060	156	149480	180	172410
230	61	67800	86	95800	105	117390	122	135480	149	165770	172	191200
240	58	74800	83	105700	101	129420	118	149360	143	182760	165	210650
250	56	82100	79	116050	97	142080	112	163960	137	200630	158	231410
260	54	88700	76	126700	93	155310	108	179240	132	212320	152	252970
270	52	97750	74	138100	90	169130	104	195190	127	238830	146	275480
280	50	106100	71	149920	87	183530	100	211810	122	259170	141	298930
290	48	114700	68	161900	84	198470	97	229040	118	280260	136	323640
300	47	123700	66	174790	81	213990	94	246950	114	302170	132	348540
310	45	133000	64	188130	78	230170	91	265630	110	325030	128	374910
320	44	142700	62	201900	76	246850	88	284890	107	318590	124	402080
330	43	152800	60	215900	74	264470	85	305220	104	373170	120	430770
340	41	162900	58	230500	72	282000	82	325450	101	398220	116	459330
350	40	173700	57	245500	70	300470	80	346770	98	424300	113	489410

Buffalo Mechanical Draft Apparatus

Standard Steel Plate Cone Wheel

Furnished with Pulleys or Buffalo Direct-attached Engines.

Buffalo Mechanical Draft Apparatus

Standard Steel Plate Cone Fans

Buffalo Steel Plate Cone Fans possess distinct advantages over other fans or disc wheels. They obviate back air currents and utilize the centrifugal force of the fan blades, with the result that they have large capacities and are economical of power. They will deliver air against reasonable resistance, often being employed to force air against a resistance of two and one-half ounces. Cone fans are most efficient when used as eduction fans for ventilating a large space and at the same time producing a pressure upon the air in a closed stoke room with the result of obtaining both ventilation and forced draft with the same cone fan.

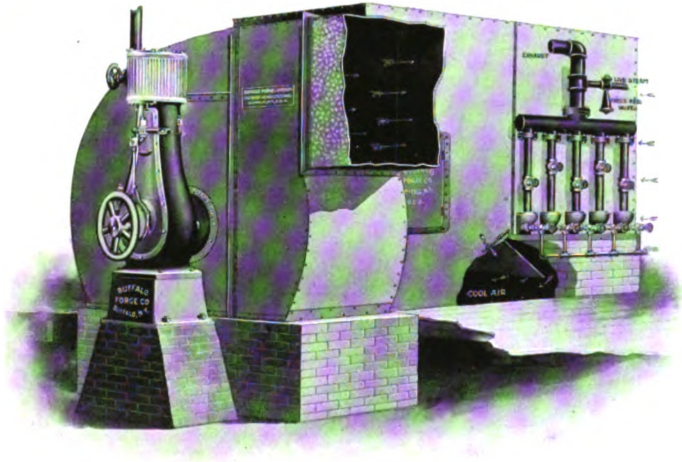
The form of the Buffalo cone wheel was adapted after exhaustive experimenting to determine the most efficient pattern, and as a direct consequence of this the power consumption for moving any given volume of air is a minimum for this style of fan. The circumferential scroll is of heavy steel plate reinforced with wrought iron bands. The wheels are made very rigid and brought to a perfect running balance.

Buffalo cone fans are built so that the top will turn to the right or left as one stands facing the inlet, and either to be driven by pulley or by direct-connected fan engine.

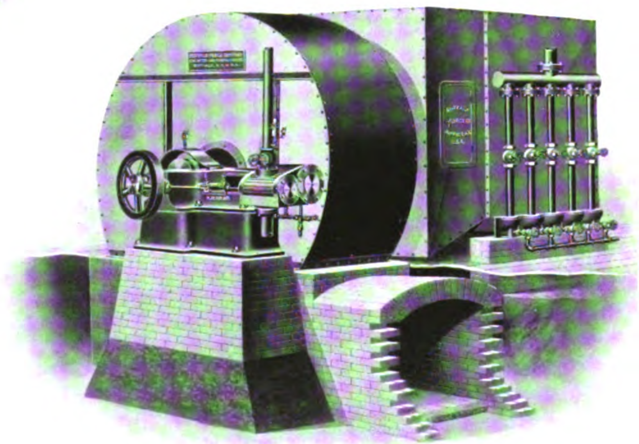
Dimensions in Inches, also Speeds and Capacities in Cubic Feet per Minute at 50° F. Discharged into Atmosphere with free Inlet and Outlet at Various Pressures.

Size, Diam in Inches.	Width at Inlet, Inches.	Width at Outlet, Inches.	Diam. of Inlet, Inches.	Pulley.		¼ Oz. Pres. 2585 Vel.		½ Oz. Pres. 3653 Vel.		¾ Oz. Pres. 4472 Vel.		1 Oz. Pres. 5161 Vel.		1½ Oz. Pres. 6315 Vel.		2 Oz. Pres. 7284 Vel.	
				Diam.	Face.	Rev.	Vol.	Rev.	Vol.	Rev.	Vol.	Rev.	Vol.	Rev.	Vol.	Rev.	Vol.
30	11	7½	22¾	8	3	329	3226	465	4559	570	5581	657	6441	801	7881	928	9090
36	12	9	27½	9	4	275	4652	388	6575	475	8049	547	9290	670	11367	773	13111
42	13½	10½	30	9	4	235	6328	332	8942	407	10957	469	12634	574	15459	662	17831
48	15	12	36¾	10	5	205	8272	291	11682	356	14310	410	16515	502	20208	579	23309
54	16	13½	38⅞	11	5	183	10464	259	14787	316	18102	365	20892	446	25563	515	29485
60	17	15	42⅜	12	6	165	12925	233	18265	285	22360	329	25805	402	31575	464	36420
66	18	16½	47	14	6	149	15634	211	22093	258	27056	298	31214	365	38193	422	44053
72	20	18	52	18	7	137	18612	194	26301	238	32198	274	37159	335	45468	386	52445
84	23¼	21	60½	20	8	118	25333	166	35799	203	43826	235	50578	287	61887	331	71383
96	26	24	68½	24	9	103	33088	146	46758	178	57242	206	66060	251	80832	390	93235
108	30	27	77	26	10	91	41877	129	59178	158	72446	182	83608	223	102303	257	118000
120	34	30	85½	30	12	82	51700	116	73060	142	89440	164	103220	201	126300	232	145680
144	40	36	102½	36	14	68	74148	97	105206	119	128794	137	148637	167	181872	193	209779
168	46	42	120	42	15	59	101332	83	143197	102	175302	117	202311	143	247548	165	285533
180	49	45	128½	48	16	55	116325	78	164385	95	201240	110	232245	134	284175	155	327780

Belted or Direct-connected Fans, Drawing or Blowing Through Heaters



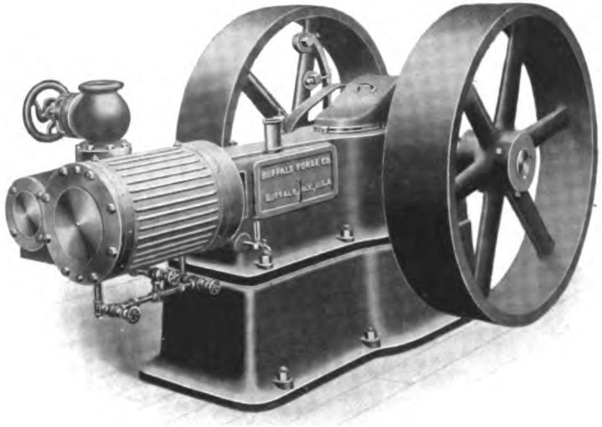
Top Horizontal Discharge Fan with Direct-attached Upright Engine, drawing through Heaters.



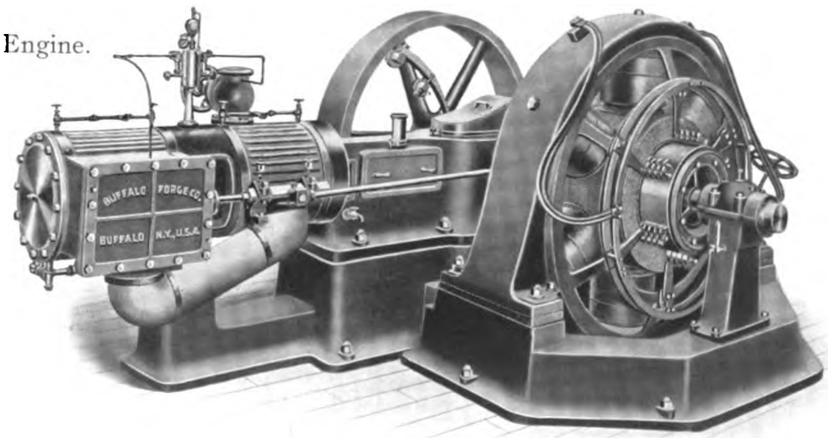
Bottom Horizontal Discharge Fan with Direct-connected Engine drawing through Heaters.

Buffalo Automatic Cut-off Engines

Simple or Compound, Direct-connected or Belted



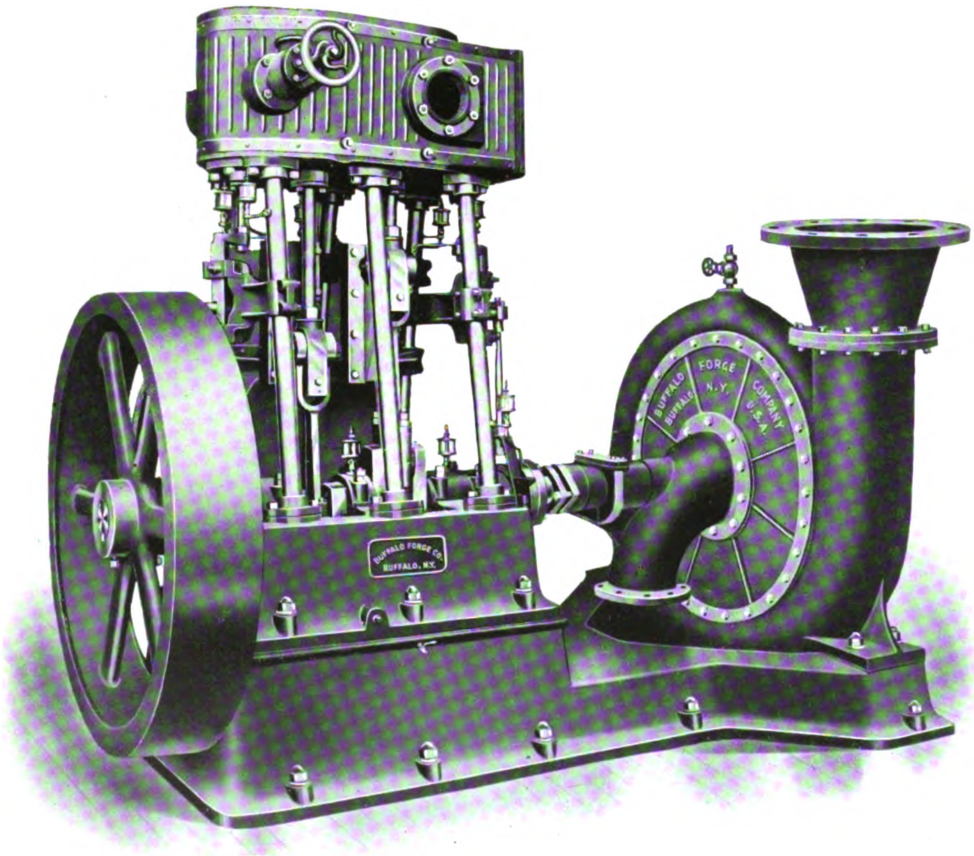
Buffalo Horizontal Center-crank Engine.



Buffalo Tandem Compound Engine, with Extended Sub-base, Direct-connected.

Buffalo Centrifugal Pumping Machinery

Single or Double Suction, Direct-connected or Belted.



Buffalo Double Suction Pump, Direct-connected to Cross-Compound Marine Engine.

Compend

The Courier Company, Buffalo, N. Y.